WavePro DSO

2001   12

LeCroy, ProBus   SMART Trigger   LeCroy Corporation   ActiveDSO, ScopeExplorer,
WaveAnalyzer   WavePro   LeCroy Corporation   . Centronics   Data Computer Corp
. Epson   Epson America Inc.   . Mathcad   MATHSOFT Inc.
. MATLAB   The MathWorks, Inc.   . Microsoft, MS   Microsoft Access
Microsoft Corporation   , Windows   NT   Microsoft Corporation   .
PowerPC   IBM Microelectronics   . DeskJet, ThinkJet, QuietJet, LaserJet, PaintJet, HP
7470   HP 7550   Hewlett-Packard Company   .

3   : WaveAnalyzer Pro

4 *:*

Wavepilot

WavePro　　　　　　　　　LeCroy　DSO
　　　Wavepilot　　　　　. Wavepilot
　　　　　.　　　Wavepilot　GRAPH　　　　　　　　　　　　　　,FFT　　　　JitterTrack™
　　　　　　　　　　　　　　.　　　　　　　**ANALYSIS PACKAGES**
　　　　,　　　　　　　　　　　　　　　　　　　　　　　　　　　.
INTRO–1　　Wavepilot　　　　　　　　　　　　　　.
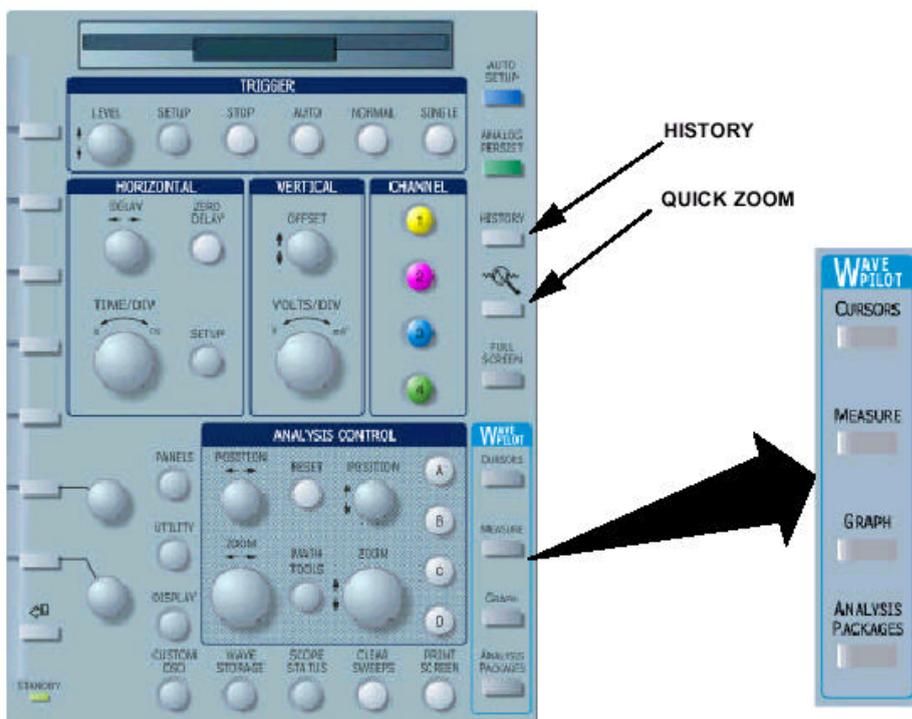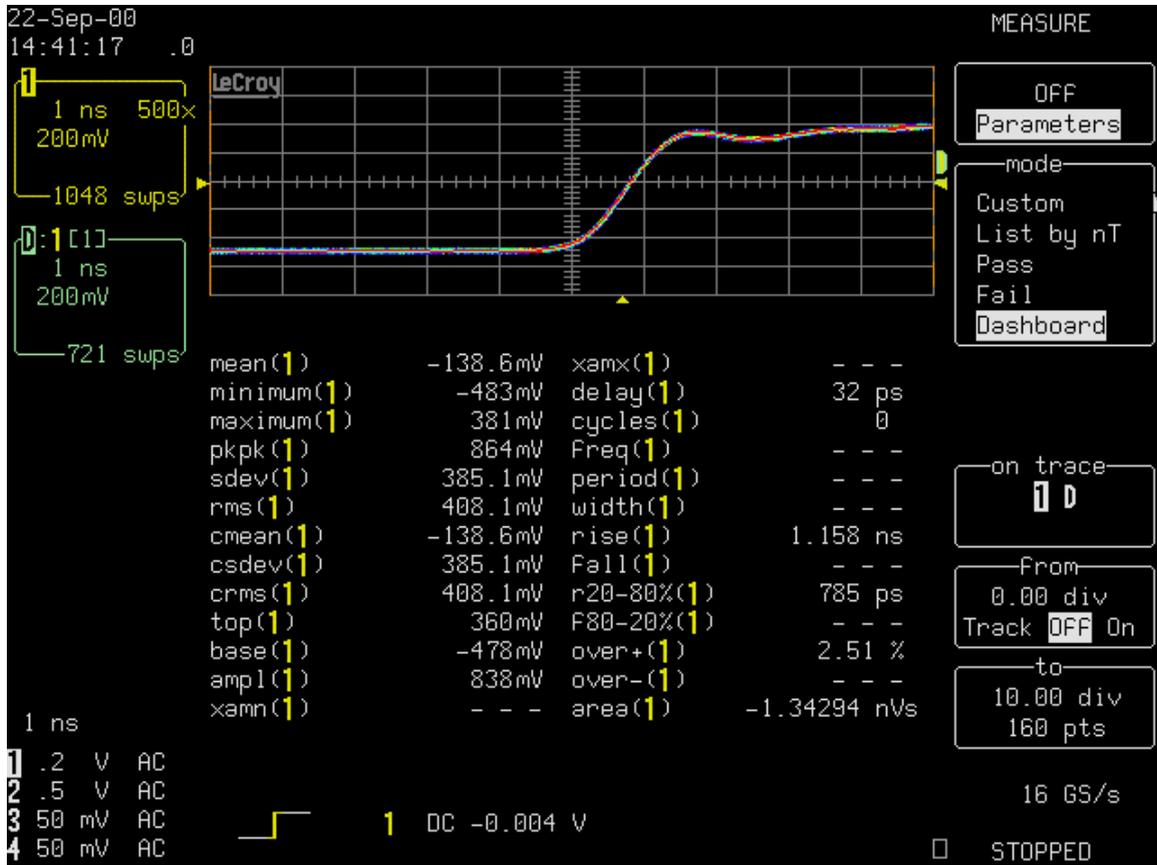
INTRO–1 Wavepilot

INTRO–2   Dashboard   Wavepilot

Wavepilot **CURSOR**   INTRO-3   .
                                                                                              .


```
22-Sep-00                                                          CURSORS
15:00:12   .0

 1                                                            OFF Cursors
  1 ns   500×
 200mV                                                          mode
   5.00 ns                                                      Time
 1048 swps                                                      Amplitude

 D:1[1]                                                         type
   1 ns                                                         Relative
 200mV                                                          Absolute
   5.00 ns
  721 swps



                                                              Reference
                                                               cursor
                                                              Track OFF On


 1 ns
                                                              Difference
 1  .2  V  AC                                                  cursor
 2  .5  V  AC
 3 50 mV  AC                                                    16 GS/s
 4 50 mV  AC              1  DC -0.004 V
                                                            □  STOPPED
```
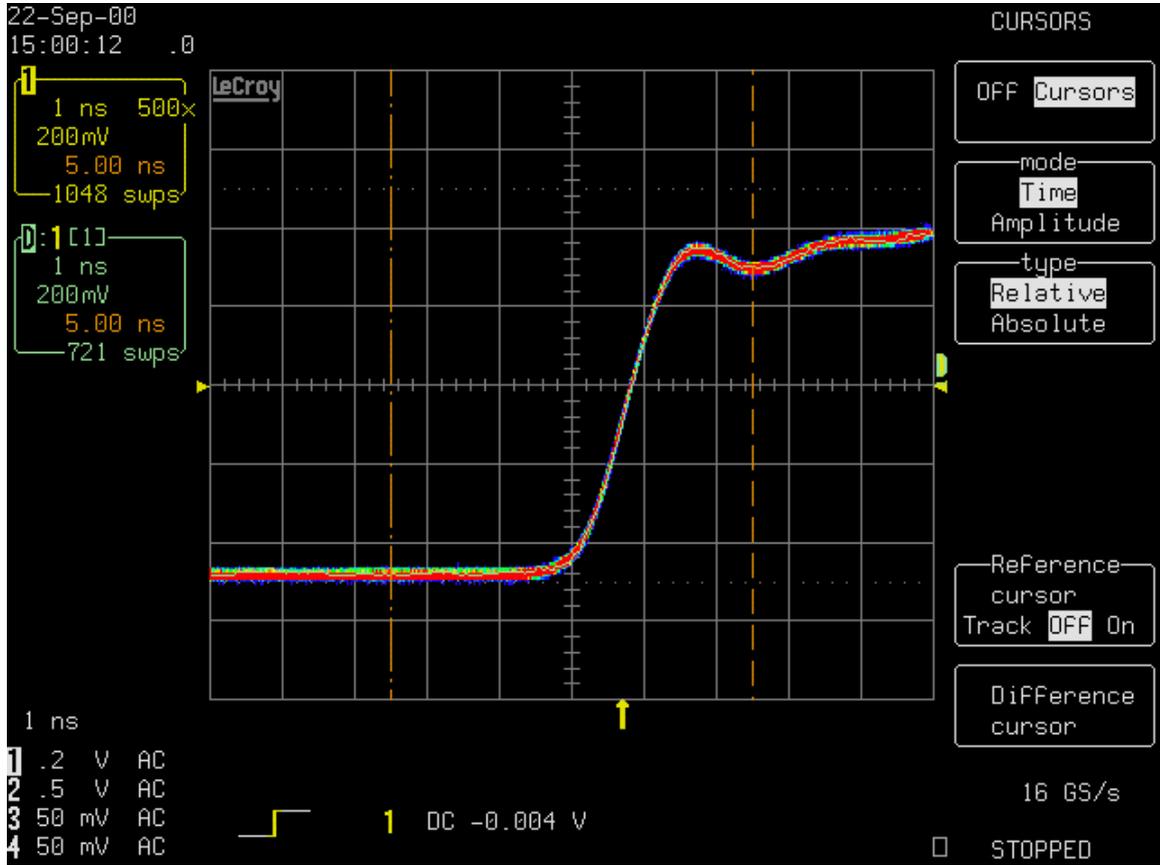
INTRO-3 CURSORS   **Wavepilot CURSOR**

UTILITY

○

                    Speical Modes → Cursors Measure   .

```
Bold Cursors
 OFF   On
```

                                                      .

QuickZoom   HISTORY

                                                QuickZoom   **HISTORY**   .
QuickZoom   .   INTRO-4
          QuickZoom   . QuickZoom
                                                      . HISTORY
HISTORY   .
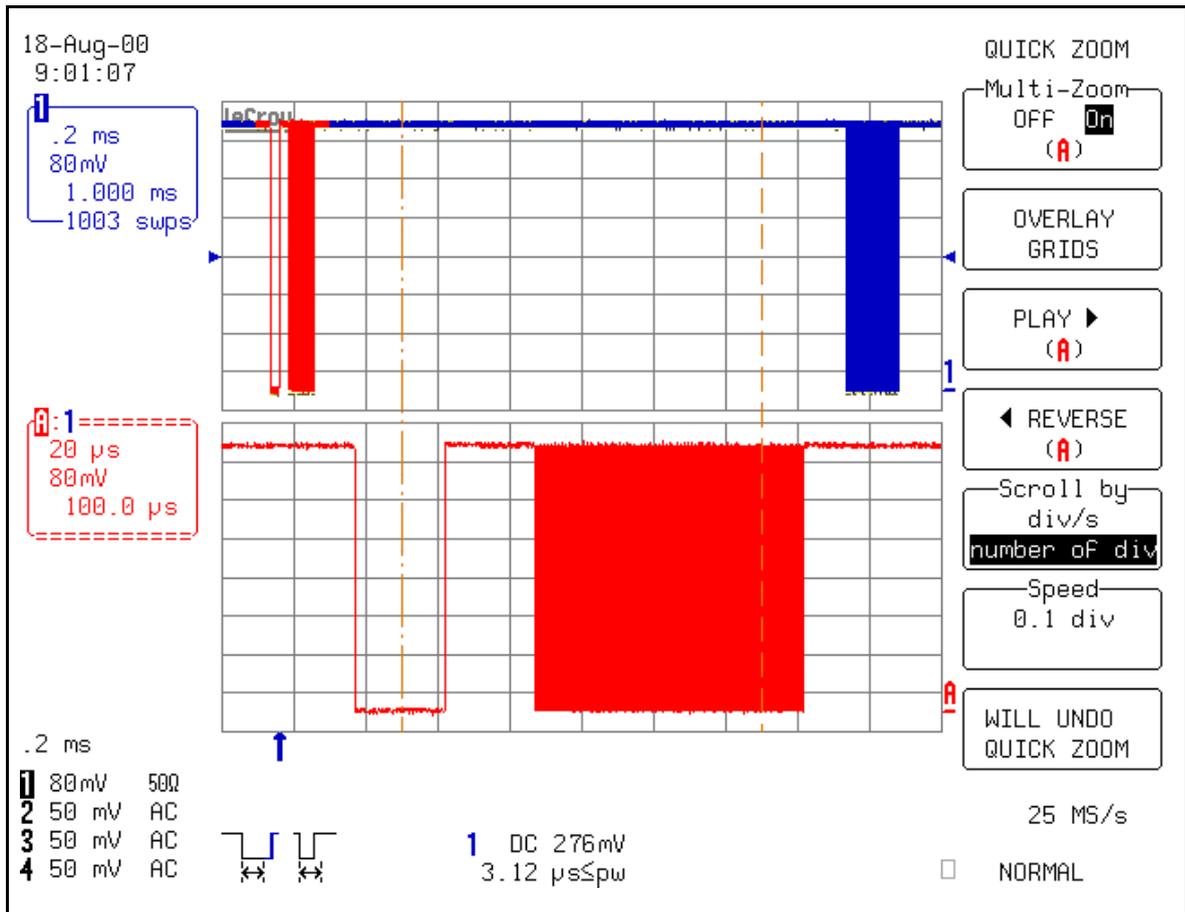
INTRO-4.   **QuickZoom**

Wavepilot Graph

.   ,
.   FFT
. FFT   . LeCroy
TrackView   . TrackView
period, width , Frequency   duty cycle   .
GRAPH   . Wavepilot   **GRAPH**
, TrackView   FFT   (INTRO-5)
.
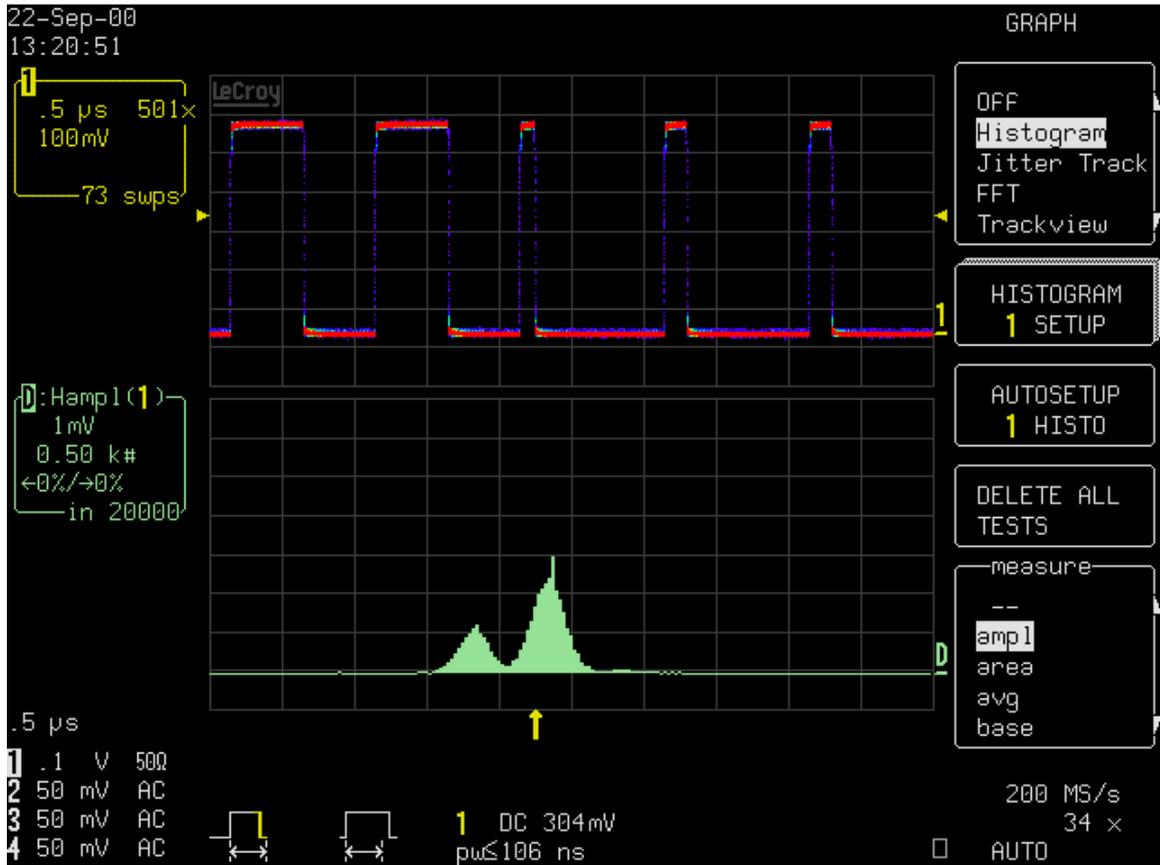
INTRO-5. Wavepilot Graph   **, JitterTrack   FFT**
.

INTRO-6   - -   .
HISTORY   .   "
.   .   "
"   .   JitterTrack view   . INTRO-6
. JitterTrack
.

15-Dec-00
6:19:38

GRAPH

1
10 µs
80mV
50.0 µs
206 swps

LeCroy

Histogram
Jitter Track
FFT

A:Jwidth(1)
10 µs
100 ns
50.0 µs

1

MORE
JITTER SETUP

FIND JITTER
TRACE

type
Width

10 µs

of
1 2 3 4 B C D
M1 M2 M3 M4

A

1 80mV   50Ω
2 50 mV AC
3 50 mV AC
4 50 mV AC

1 DC 276mV
pw≤102 ns

4 GS/s

AUTO
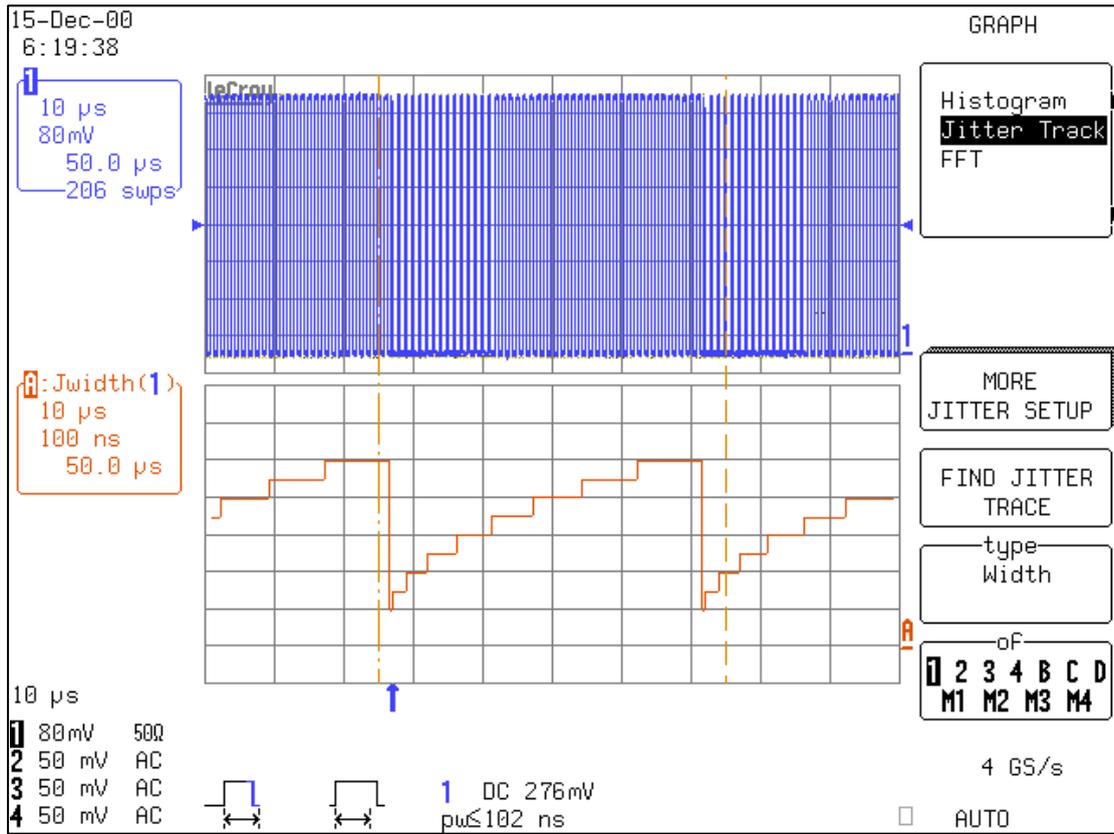
INTRO-6   -   **FFT**
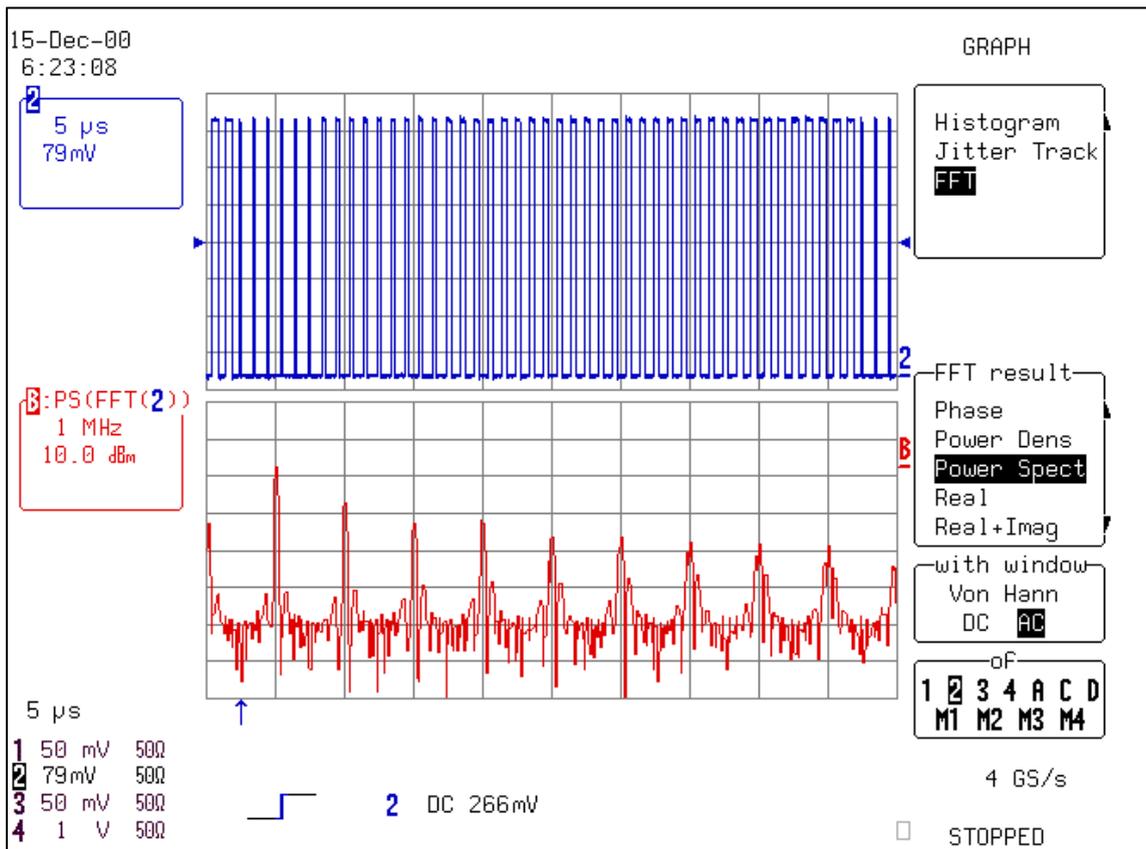
INTRO-7   FFT   . FFT
          1 MHz   .
                              .

INTRO-7:FFT of a pulse-width modulated signal taken over one cycle of the width modulation

"   "   .

CUSTOM DSO

DSO
.   DSO   .
?
?
?
,PC   (   )   .

CUSTOM
DSO

1.   .

2.

CUSTOM DSO

TIF2FLPY

OFFVOLTS

.

.

.
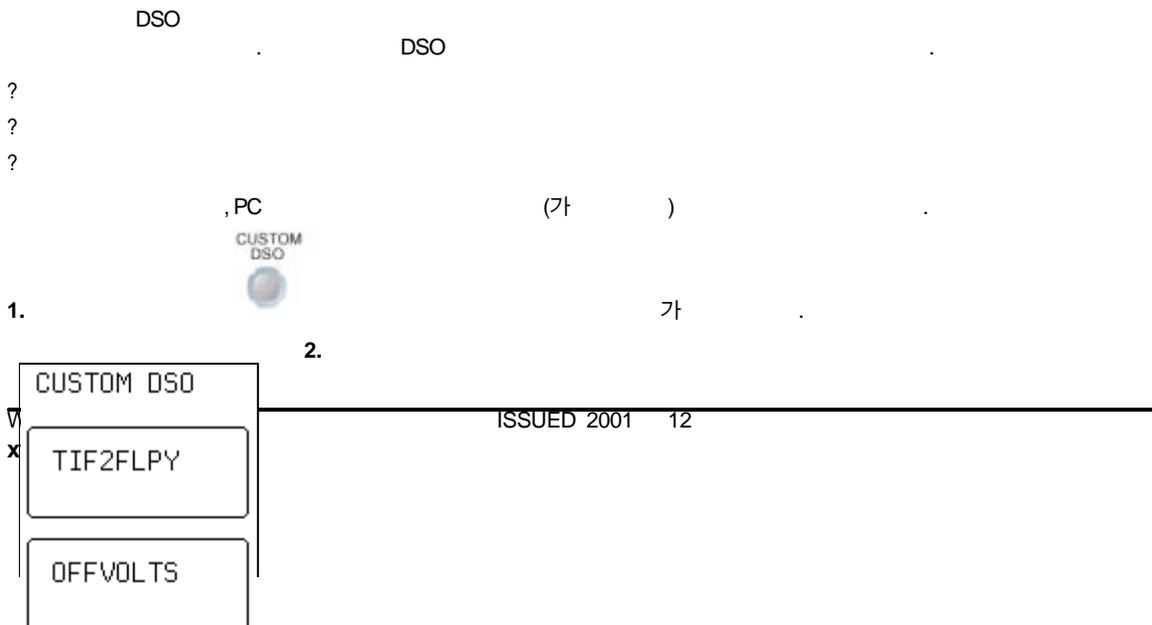
dBm   volts   .

LeCroy   .

.

.dso   .

(   )

Map File
to Key

.

1   6

SETUP CUSTOM   .

Key   .

1 2 3 4 5 6   .

1   . PC

On Drive   . **Vdisk**   .

Card

Flpy Vdisk   (   )   **Vdisk** "On Drive"

Map Math and   .   .

Parameters

to Key 2   .

Key 2 runs   .

FAVORITE.DSO   .

on Vdisk

File   .

CUR_VOLT DSO

LOGO_OFF DSO   .

LOGO_ON DSO

DEFAULTS DSO

FAVORITE DSO

SET CUSTOM

TO DEFAULT

(PC   )
    (Vdisk)   .

    WavePro DSO   RAM   .
                          .

 (mapping)   .

TA:DEFINE?
TB:DEFINE?   .
TC:DEFINE?
TD:DEFINE?
PACU? 1
PACU? 2   .
PACU? 3
PACU? 4
PACU? 5

                               .

A:DEF EQN,"HIST(CUST1)",MAXBINS,200,MAX_EVENTS,2000,CENTER,7.48389,WIDTH,1,VERT,LIN
TB:DEF EQN,"PS(FFT(TA))",MAXPTS,1000,WINDOW,RECT,DCSUP,ON
TC:DEF EQN,"HIST(CUST3)",MAXBINS,100,MAX_EVENTS,1000,CENTER,0E-3,WIDTH,1,VERT,LIN
TD:DEF EQN,"PERTRACE(C2)",PTR_TYPE,AVG
PACU 1,AMPL,C1
PACU 2,SDEV,C1
PACU 3,MAX,C3
PACU 4,FALL,C1
PACU 5,WIDLEV,C1,POS,0E-3 V,1 DIV

Custom parameter(PACU)
       .

INTRO-8. DSO

Custom DSO

CustomDSO   .dso   ASCII   .   .dso
                .   , PC   ,   ScopeExplorer   .
                                                LECROY_1.DIR   'AUTOEXEC.DSO'
                        .   .dso
                                        .

Windows   CustomDSO   .   INTRO-9
                AUTOEXEC.DSO   .

INTRO-9.   **(KEY   )**   **.dso**
                               autoexec.dso

ScopeExplorer

ScopeExplorer(a free utility)

.   ScopeExplorer   .dso   .   INTRO-10   A

2   FFT   .

DEFINE?   " **TA:DEF EQN, …**"   .

INTRO-10

.

"RCPN DISK,FLPY,"P000.PNL'"

.

Internal Remote Control Assistant (RCA)   CustomDSO

. RCA   Utilities   .   INTRO-11

RCA   .

CustomDSO

.

INTRO-11.   **(, TE,   )**   **Remote Control Assistant**

# WAVEFORM HISTORY

Analog Persistence   History
                                    .
                    .

LeCroy   WavePro   .
                    " History "   .   INTRO-12
121   Intensity grading Analog Persistence   . Intensity grading
   .   .

Trace D is automatically enabled when you press the HISTORY button. When you turn History mode off, Trace D turns off also.
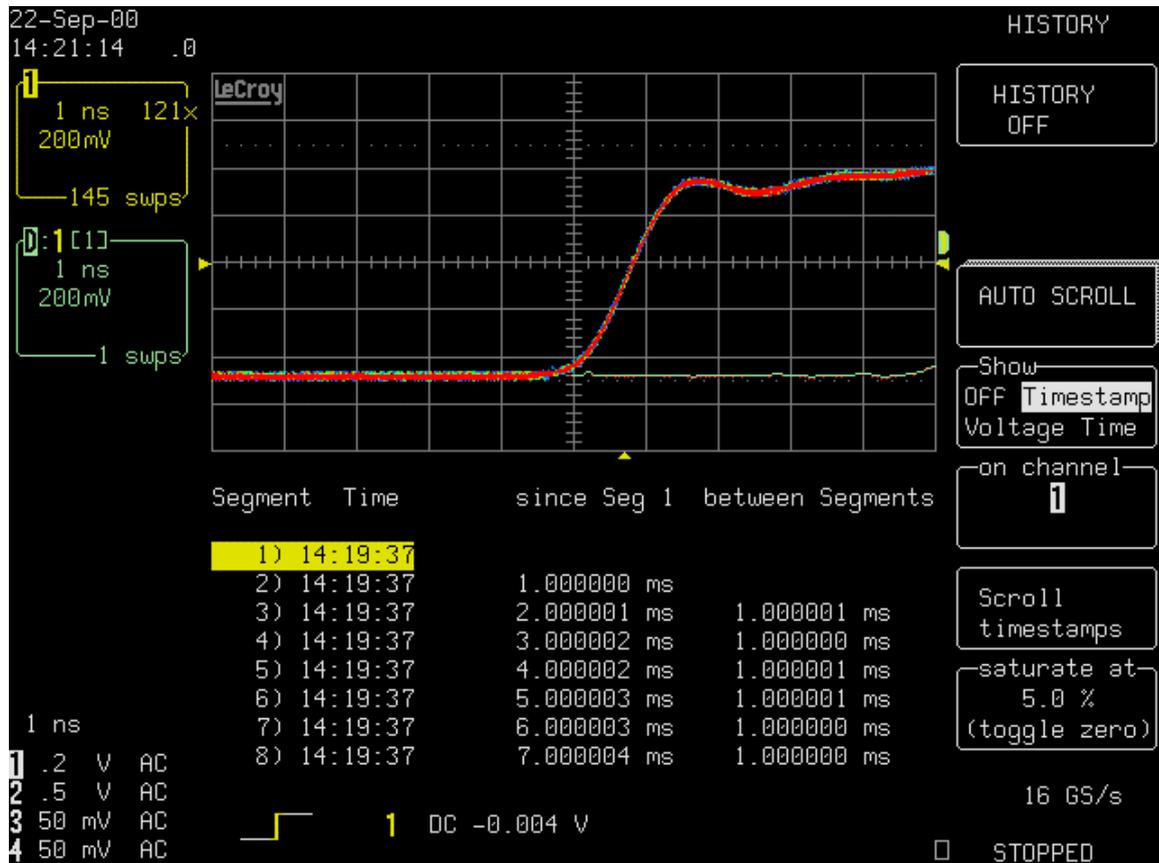
INTRO-12 HISTORY   **, Analog Persistence   HISTORY   .**
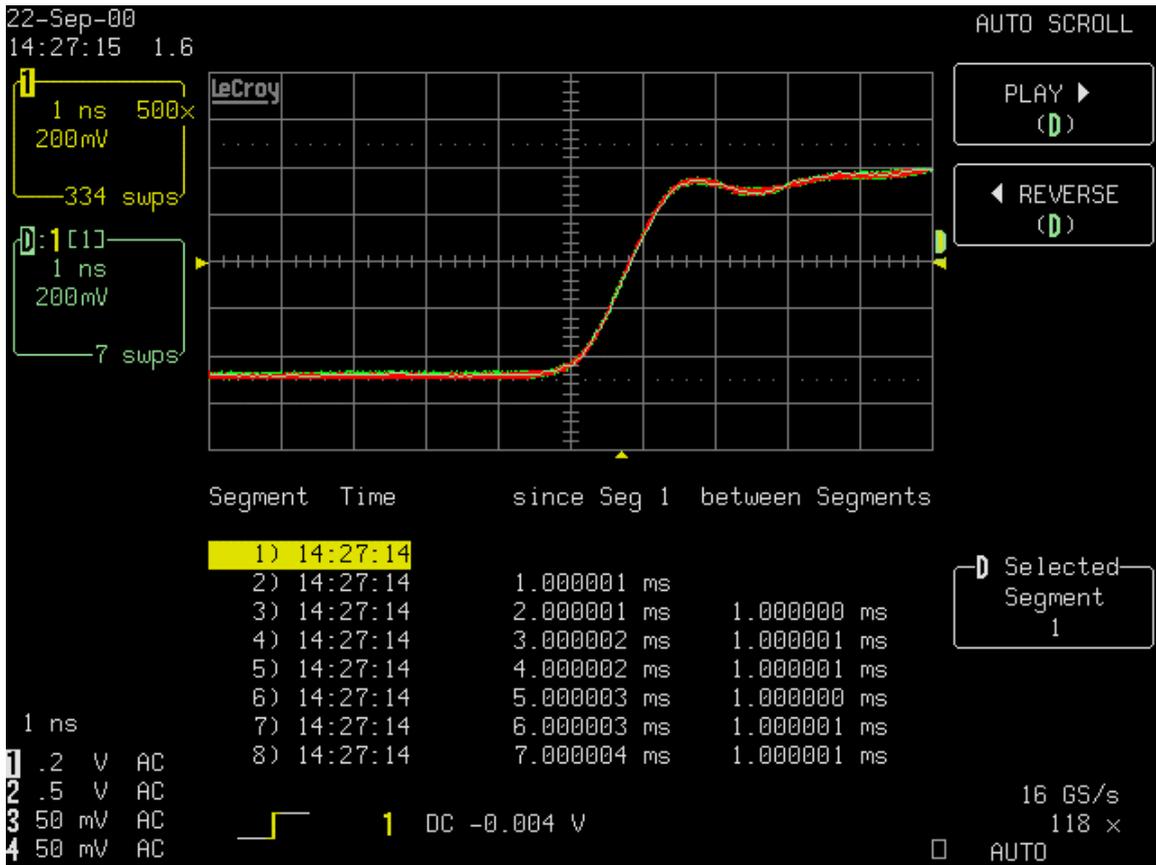
INTRO-13. Analog Persistence
Play   Reverse

8000

Analog Persistence   INTRO-12
. Analog Persistence   INTRO—
13   **Play   Revers**e
   . Analog Persistence

                                                                    Slew Rate
                                   INTRO-14

INTRO-14.   **1.4 ns**   **Slew Rate**

Slew rate   Slew rate

             .   INTRO-15   .
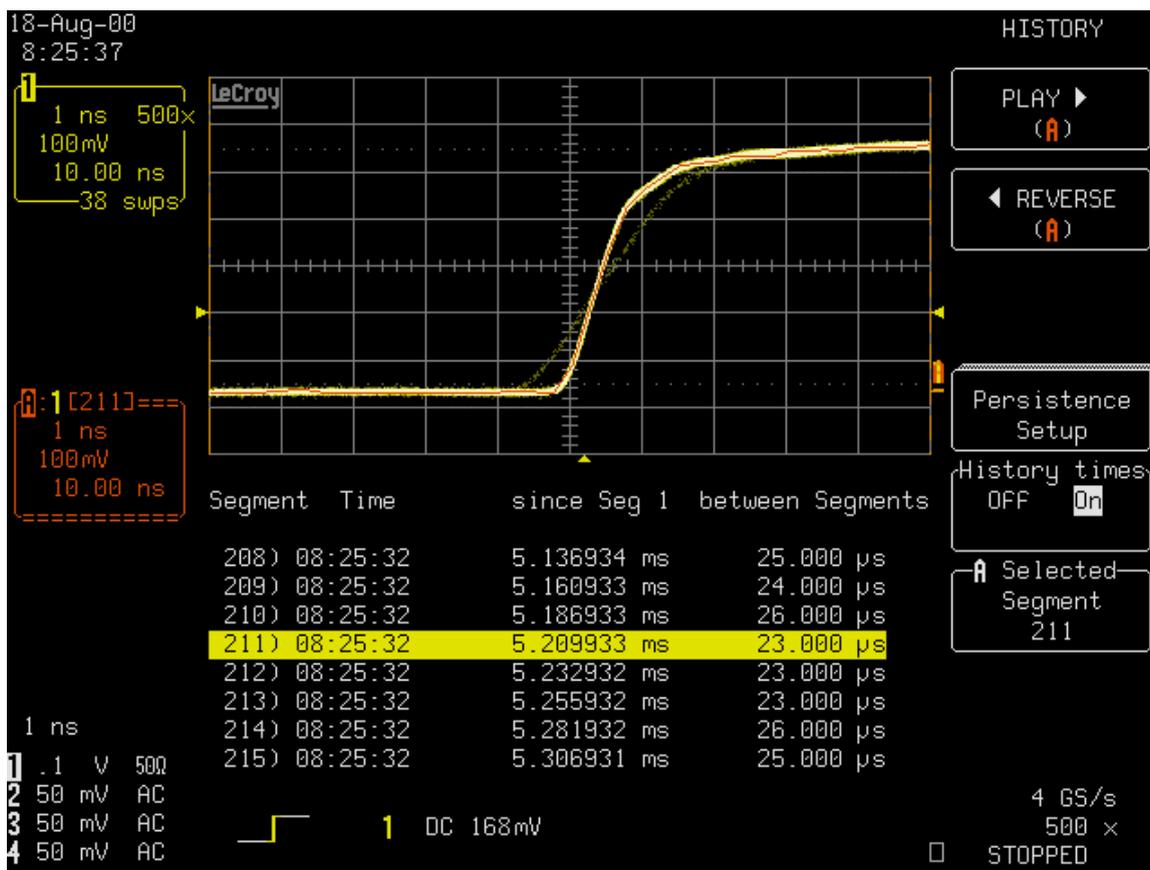
INTRO-15. SMART Trigger .

History   Analog Persistence
                                        .

![wavepro logo]

WavePro   "1-2-3"   .
   .
          WavePro DSO   .   .
                                                      .
                                                              .

   1   "   "   .
WavePro DSO   .
   2   "   "   .   *WavePro* DSO
                                                      .   1
          .   .

   3   "   "   WAVA   .
                                    .

   4   "   "   LAN   *WavePro* DSO   .
                                                            .
                                                            .

          "   "   *WavePro* DSO
                              .

          "   "   .

                                                                              "   "   .
                                                .

                              §§§
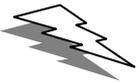
First Things … First

.

✧

✧

✧ *Wavepro*

✧

✧

✧

✧

✧

✧ ,

✧

DSO

,   . (.)
　WavePro   SYSTEM STATUS   (xli   ).
　　　　　　　　　　　　　　　　LeCroy   .
　　.

　　　　　　　　　WavePro   .

- ✧ *10:1 10M   PP005 Passive Probe - one per channel*
- ✧ *AC Power Cord and Plug*
- ✧ *Performance of Calibration Certificate*
- ✧ *Front Scope Cover*
- ✧ *Two 250 V Fuses*
- ✧ *Operator's Manual*
- ✧ *Remote Control Manual*
- ✧ *Quick Reference Guide*
- ✧ *Declaration of Conformity*
- ✧ *CD ROM*

> *:*
>
> *,*
>
> *. LeCroy*
> *,*
> *.*
>
> *.*
> *LeCroy*
>
> *.*

WavePro   2
　　　　　　　. LeCroy
　　　　.　　,   ,   ,
　　.

　　　　　　　　　　　　　　　　　90   .
　　　　　　　　　　　　　　　　　　　　　　　　　　. LeCroy
　　　　　　　　.

　　　　　　　　　　　　　　　　　.　　　　　　　　　　　　　　　　　　　　　　2
　　　　　　　　　　　　　　　　.　　　　　　　　　　　　　　　　　　, 　,
　　　　　　　　　　　　.　　LeCroy
　　　.

,   .

LeCroy

(xliv   ).

> **:**
>
>   .
>
> .
> **4   (10cm)**
>
> .
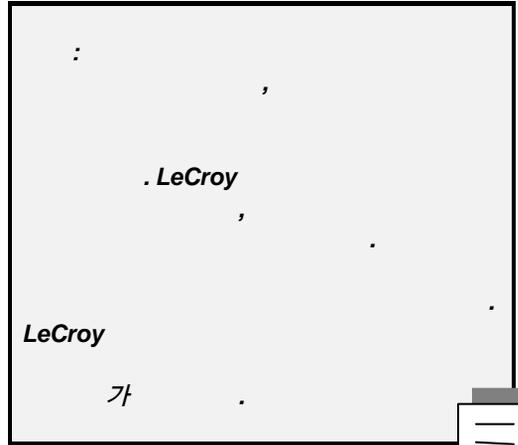
RAN(Return Authorization Number)   . LeCroy

.

.

.   LeCroy   .

.

.
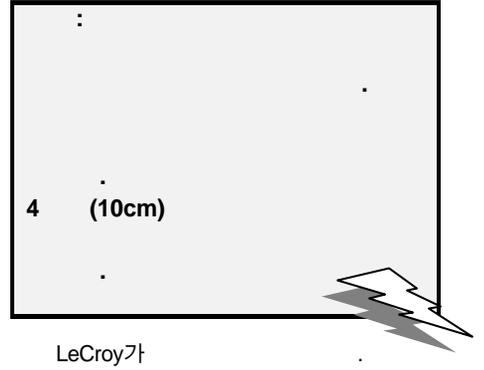
. LeCroy   COD(   )

.   .

WavePro   . LeCroy

.

.

,   . WavePro DSO   ID,

.

.   LeCroy

.

ScopeExploer™   ActiveDSO   .

ScopeExplorer   GPIB(IEEE 488)   RS-232   ( )   Microsoft®
Windwos™   PC   WavePro DSO   PC   .
                    LeCroy   ScopeExplorer
                                PC   . WavePro   ScopeExplorer
                    12   "WavePro DSO   PC   "   .
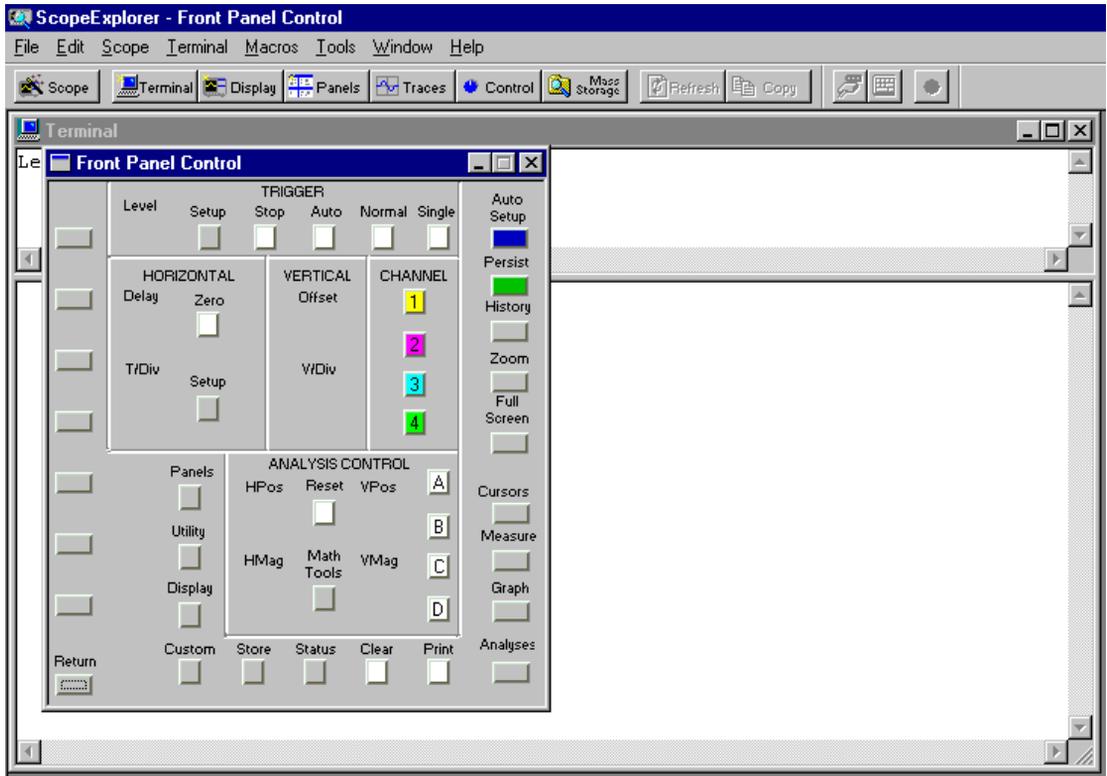
ScopeExplorer .

Windows 95, 98, Nt, 2000   Me   PC   **ActiveDSO**   MSOffice, Internet Explorer,
Visual Basic, Visual C++   Visual Java   ActiveX   Windows
                                                . ActiveDSO
                                                                                        . OLE
                                ActiveDSO
            . ,   Excel   Word
MathCad   Java, C++   Excel(VBA)   .

http://www.lecroy.com/software
.

WavePro DSO

.

WARNING . WARNING

.

CAUTION .

CAUTION .

. (   )

.

Chassis
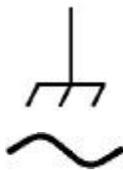
WavePro DSO   .

                                            .

✧   : 5 ~ 45

✧   :25   75% RH(   ). 45   50% RH

✧   :25   3,000m, 45   2,000m

**   :**
WavePro DSO   EN
61010-1   . :
✧   **1**

✧   **(   )**

✧   **2**

⚠ **CAUTION**

                    .

⚠ **CAUTION**

                                DSO
                                .

AC

WavePro DSO   115V(90 ~ 132V)AC   , 45 ~ 440Hz
      220V(180 ~ 250V) AC   , 45Hz ~ 66Hz   .
                  :<350VA

                                                                    .
5x20mm   (T6.3A/250V)   .
                                                             .

:		
WaePro DSO		
		.
Voltage Range:	**90-132 VAC**	**180-250 VAC**
Frequency Range:	**45-440Hz**	**45-66Hz**

WavePro DSO   3
            3   .
      DSO   .

            .
      :
STANDBY   .

⚡ **WARNING**
.
.

/
On/Standby   DSO   . DSO
            . (13 watts   )

DSO   DSO   (   )   .   DSO
                  DSO   .
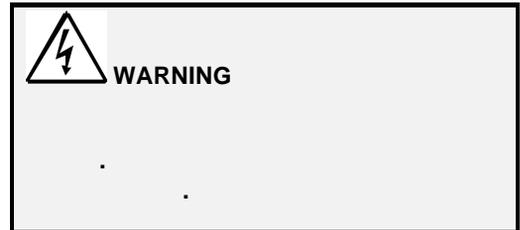
STANDBY

.

(   )   .
5x20mm   .(T6.3A/250V)

 WARNING

.

1   .
.

WavePro DSO   .   .
.
.

DSO   .

 WARNING

.
.

DSO   . DSO
STANDBY
.
.

 WARNING

. **WavePro
DSO**
. **WavePro DSO**
.

CAUTION

(CH1, CH2, CH3, CH4,
EXT)   .

WavePro DSO   -

WavePro DSO

WavePro DSO

    :

      LEVEL   . Level   .

    :

      SETUP   .
                              .

      STOP   .
      AUTO
                .

      NORMAL
              .

SINGLE

STOP   .

:

DELAY

. **DELAY**
.

TIME/DIVISION

. **DELAY**
.

:

ZERO DELAY   delay   .
.

SETUP   **TIMEBASE**   ,   ,
.

:

OFFSET   (1, 2, 3   4)
.

VOLTS/DIV   (1, 2, 3   4)   Volts/Division   (
)   .

:

1, 2, 3, 4   ,
.   (FIND)

.   .

:

? POSITION   .
.

? ZOOM   (   )   .

?POSITION   .

?ZOOM   (   )   .

:

A, B, C, D

.   . A, B, C

D   ,   ,   (   )

.   .

RESET   (   )   .

MATH TOOLS   overview

.

Wavepilot   :

CURSORS   .   dBm

.

MEASURE   26   .

,   FFT   .   /

5   .

GRAPH   Track View   FFT

.

ANALYSIS   . Jitter & Timing Analysis,

PACKAGE   .

:

AUTO SETUP   (   ),

.

ANALOG PERSIST   (   )

,   3   3   .

HISTORY   history   1ns

8000   . History view

.

QUICKZOOM   view   .

.

FULL SCREEN

.

CUSTOMDSO   NVRAM   .

CustomDSO   .

:

PANELS   (Panels)   (VDISK)   PC
.   Panel
.

UTILITY   ,   ,
.

DISPLAY   X-Y   ,   (PERSISTANCE),   ,
.

WAVE STORAGE   PC   .

SCOPE STATUS   ,   ,
.

CLEAR SWEEPS   ,   , FFT   ( )
.

PRINT SCREEN   , PC Card Hard Drive,
.

:

.   ,
.

.

RETURN

.

STANDBY Lamp   The STANDBY lamp indicates when the scope has placed itself in standby mode. In this mode, current settings are retained. The lamp does not indicate the standby mode that is induced when you turn off the power switch.

1.   WavePro DSO   .(xxxviii   )
2.   . (   )
3. DSO   On   .

.   STANDBY LED   .   10
.

UTILITY

4.　　　　　　　UTILITIES　　　　　⬭　　　　　　　　　　　　　　.

5.　　| Time/Date
　　　　　Setup |　　　　　　　　　　　　　　　　　　　　　　.

WavePro DSO　　　-

RS-232-C　　　Centronics　　External Monitor　　10BaseT Ethernet　　PC Card Slot　　GPIB
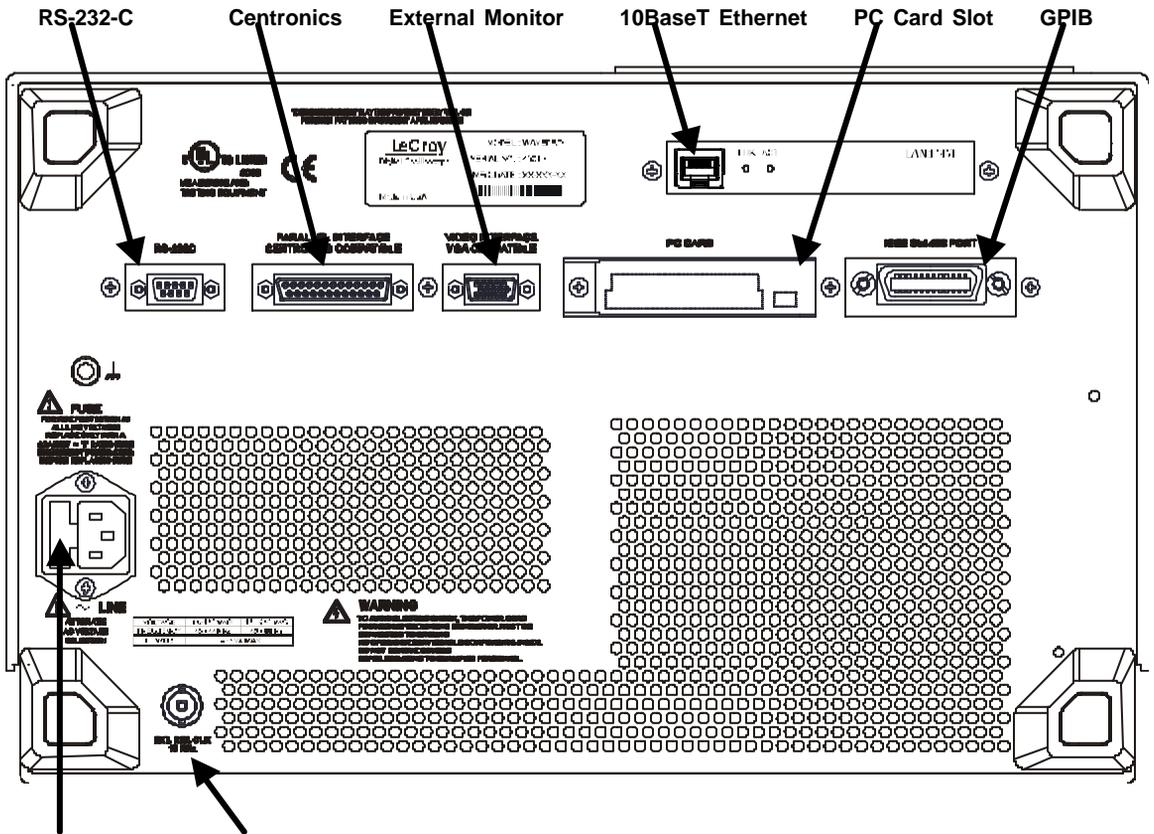
RS-232-C, GPIB　　Ethernet　　　　　　　　　　WavePro DSO
　　　　　　　　　　　　　　　　　　　　Centronics 　　　　　　　　　　　　　　　　　　　.
PC　　　　　　　　　　　　　　　　　*PC*　　　　　　　　　　　　　　　　　*BNC*
　　　　　.

Trace
OFF   On

ZOOM

PANELS

Wwavepro

WavePro .

PANELS

1. 　　　　　　　PANEL SETUPS　　　　　　　.

```
┌──choose──┐
│ Recall (or)│
│   Save     │
└────────────┘
```
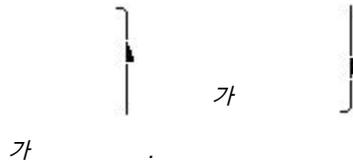
2. Recall .
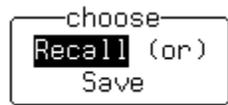
3.
```
┌──────────────┐
│ FROM DEFAULT │
│    SETUP     │
└──────────────┘
```

WavePro DSO .

WavePro DSO

SCOPE STATUS

```
┌──────────────┐
│ Acquisition  │
│ System       │
│ Text & Times │
│ WaveForm     │
│ Memory Used  │
└──────────────┘
```
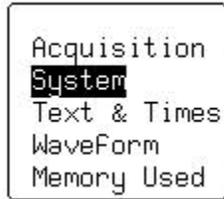
1. (STATUS) .

2. System . WavePro DSO , .

3. LeCroy .
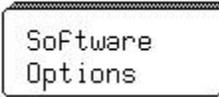
System   ,   . | SoFtware Options |

                                                    .   WavePro DSO
     .

1. | ADD OPTION KEY | .

2.   ADD OPTION   .   WavePro DSO
                                        .   LeCroy   .

WavePro DSO   .

                                                              .

     .

UTILITY

1. ○   UTILITES   .

2. | Special Modes | | Firmware Update | .
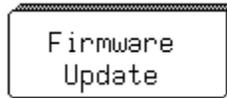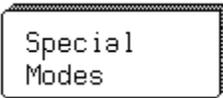
3.   WavePro DSO   Floppy   Card   Update Flash
                    .   System Status   . (   )

4.   ScopeExplorer   .

          (   )

WavePro DSO   .

DISPLAY

1. ○   DISPLAY SETUP   .

2.   "More Display Setup"   . | Screen Saver Setup |

3.

```
┌──enabled──┐
│ No  Yes   │
└───────────┘
```

Yes **No** .

10 .

" " . STANDBY

LED . LED .

.

.
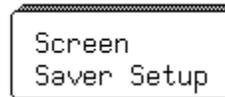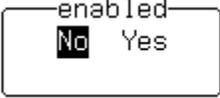
UTILITY

1. ○ UTILITIES .

2.
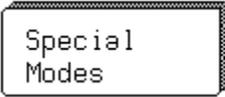
```
┌─────────────┐
│ Special     │
│ Modes       │
└─────────────┘
```

```
┌─────────────┐
│ Front Panel │
└─────────────┘
```

.

3. USER PREF .

On

.

(audible feedback) **O**n

" " .

§ § §

1

1 **WavePro DSO** .

.

. . .

. .

1 :

.

✧

✧

✧

✧ *(Time base),*

✧ **–**

✧

✧

✧

✧ *CAL BNC*

.

1. WavePro DSO (1).

AUTO
SETUP

2. , ( )
.

3. 1 1 .

4. .

CHANNEL **1**

—Trace—
OFF **On**

1 .

:

Coupling

. 1-9 .

ZOOM

.

. 1-7 .

FIND

" " .

" "
. 1-4 .

—Gain—
Fixed
variable

.

:AUTO SETUP   50Hz
 0.1%   5mV   40V

.

—Grids—
Single Dual
Quad Octal

3 " " .

W wave**pro**


```
29-Sep-98                                          CHANNEL 1
14:40:36
                                                   ┌─Trace───┐
1                                                  OFF   [On]
  1 µs
  20.0mV                                           ┌─────────┐
                                                   │ Coupling │
                                                   └─────────┘
                                                   ┌─────────┐
                                                   │  ZOOM   │
                                                   └─────────┘
                                                   ┌─────────┐
                                                   │  FIND   │
                                                   └─────────┘
                                                   ┌─Gain────┐
                                                   [Fixed]
                                                   variable
                                                   ┌─Grids───┐
  1 µs                                             [Single] Dual
1 20 mV  DC                                        Quad Octal

2 .1  V  AC        ┌─┐    1  DC 70.0mV             500 MS/s
               ___┘ └_
                                                   □   NORMAL
```
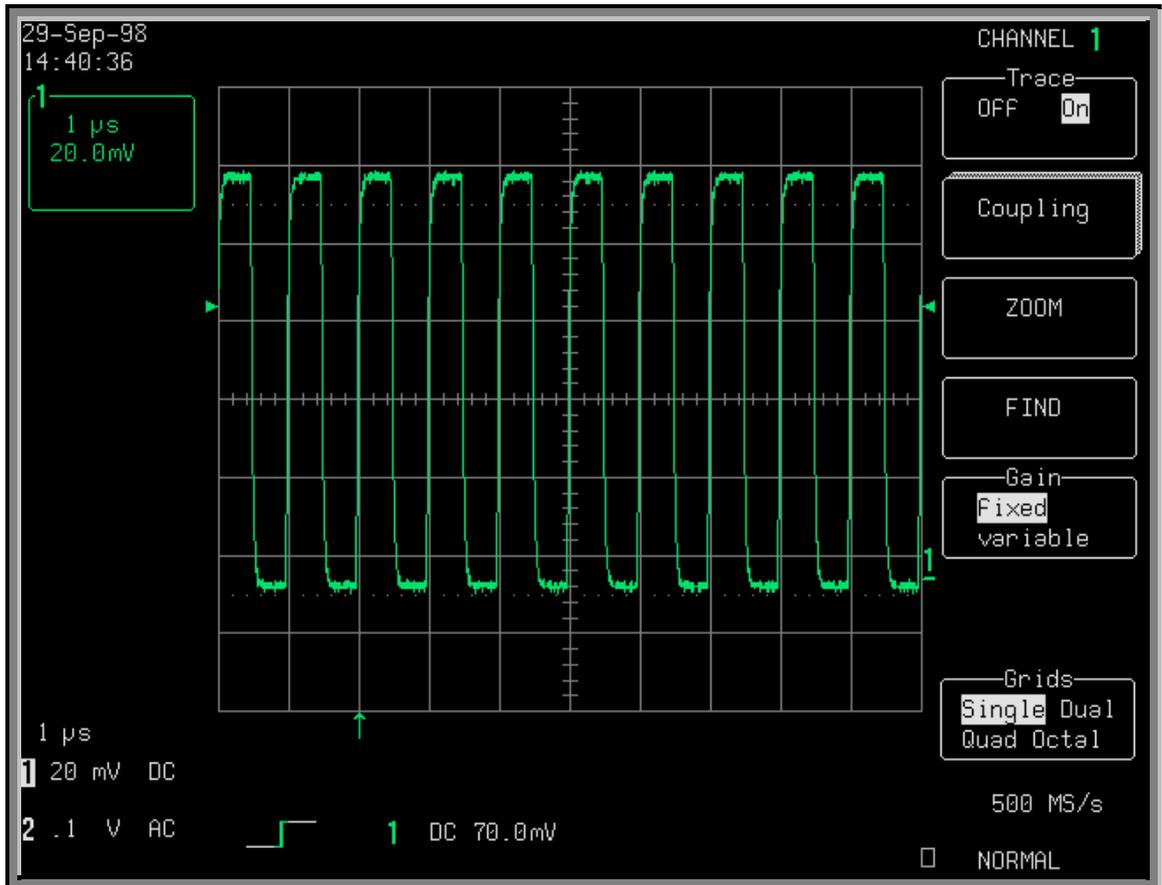
WavePro DSO

```
11-Aug-00
 9:37:14 33.2
```
Real-Time Clock field:
                                      .

```
1
  1 ms
  100mV
```
Displayed Trace Label   ,   /   /
                                          .

Acquisition Summary :   ,   /
                  ,   .

                                                                                                                        .
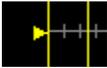
Trigger Status   *(AUTO, NORMAL, SINGLE,*
STOPPED)   .
                  .`

Trigger Configuration   ,   ,
                                                                                .
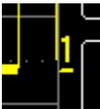
Trace Ground Level   .

A.   ***Time and Frequency***
                                                      Message   .   ***3***   ***"***
            "   .

Time/Div

TIME / DIV

s   ns

.

: AUTO SETUP

.

.

.

1-2-5   . WavePro DSO
.   time/div
.

VOLTS / DIV

V   mV

UTILITY

:   *Special Modes*

.

.
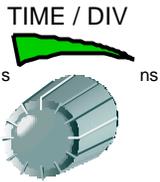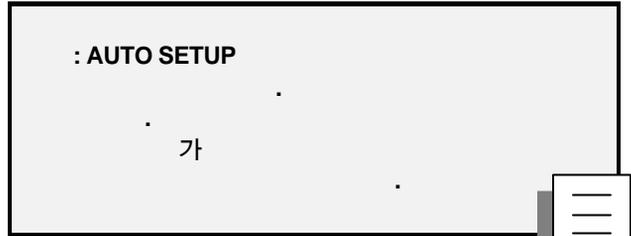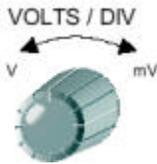
1.   VOLTS / DIV
. volts/div   1
.
(   )

.

2.   "Variable"
. (1-1   )

3.   VOLTS/DIV

.

digitizing   .
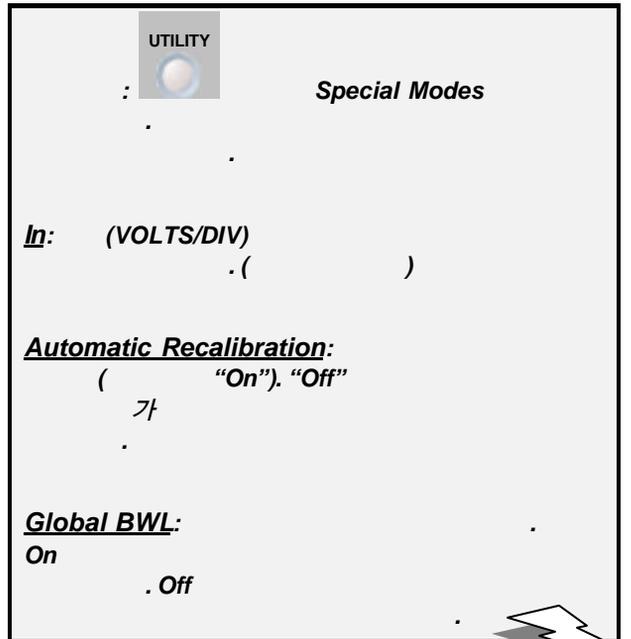
In: *(VOLTS/DIV)*
. (   )

Automatic Recalibration:
("On"). "Off"

.

Global BWL: **.**
On
. Off

.

OFFSET

4. OFFSET ▲▼ .

SETUP

1. HORIZONTAL TIMEBASE .

2. .
7 , " " .

```
 TIMEBASE
T/div 20 ns
     800
samples at
  4 GS/s
(250 ps/pt)
For  200 ns
┌─Sampling─┐
Single Shot
     RIS
┌Sample Clock┐
  Internal
 ECL 0V TTL
┌─Channel Use─┐
 4   2   1
 Automatic
┌─Sequence─┐
 OFF    On
┌─Record up to┐
     4M
  samples
```

Single-Shot

.

.

Internal **–ECL, 0V, TTL-** .

.

7 , " " . 8 , " "

.

On Off .

" . 7 , "

100k .

WP-OM-K Rev A   ISSUED 2001   12   **1-5**

ZOOM   .   .

1. QUICK ZOOM   TRACE A   .

.

2.   .

QUICK ZOOM

┌─Multi-Zoom─┐
OFF On
( )

OVERLAY
GRIDS

PLAY ▶
( )

◀ REVERSE
( )

┌─Scroll by─┐
div/s
number of div

┌─Speed─┐
0.1 div

WILL UNDO
QUICK ZOOM

MULTI-ZOOM   AUTO SCROLL
.

Off   . On
(A,B,C,D)   (   ) Auto Scroll   , (   )
ZOOM   POSITION   . Multi-Zoom
.

.

.

"STOP(PLAYING)"   .   .

.

"STOP(REVERSING)"   .   .

. div/s
.   /
number of div   .

.

"10div"
"   "   .

.

.

POSITION

1. POSITION ▲▼ Trace A

.

ZOOM

2. ZOOM .

POSITION

3. POSITION .

ZOOM

4. ▲▼ .
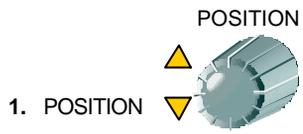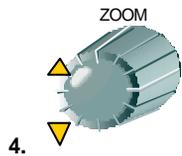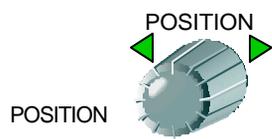
A.

.

Trace A   *Trace B*
.

A.

B. Multi-Zoom

.

(A, B, C, D)
.

.

C.

```
A:1=========
50 ns
100mV
=========
```

1. Coupling

2.

CHANNEL **1**

Coupling
DC50Ω
Grounded
DC1MΩ
Grounded
AC1MΩ

V/div Offset
NORMAL
ECL   TTL

Global BWL
OFF
20MHz 200MHz

Probe Atten
×1
×2
×5
×10
×20

NORMAL , volts/div ECL
. , TTL .
,

Off 200MHz 20
MHz .
. Gobal BWL .
BWL . SPECIAL
MODES 1-4
.

.

. LeCroy ProBus®
.

. ProBus
.

:
◇ *AC* *:* *DC* *10Hz*
.
◇ *DC* *:* *1 ? 50*
. 50 *0.5W* *.*
. " Grounded" *" Coupling"* *Acquisition*
Summary *.* *" DC5Ω"* *.*

CAL   BNC

UTILITY

1. UTILITY   .

CAL BNC
Setup
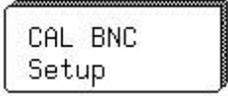
2.   CAL BNC OUT   .

CAL BNC OUT

mode

CAL signal
OFF
Pass/Fail
Trigger Out
Trigger Rdy

3.   CAL   BNC
                        .   ,   .

BNC   .

SET TO 1 kHz
1 V SQUARE

CAL   . 1kHz 1V   WavePro DSO
                                                      .

Shape

Square
Pulse(25 ns)

Amplitude
1.00 V
into 1 MΩ

CAL   (:1M   0.05 ~
1.00V   )   . 50
                                                      .

Frequency
1 kHz

500Hz   2MHz
CAL   .

WavePro   *LeCroy*   *.*

A.   *WavePro*   *.*

B.   *1*   *.*

C.   *CAL*   *("*   *"*   *).*

D.   *Lead's alligator*   *CAL*   *.*

E.   *CAL*   *1kHz*   *1Vp-p*   *.*

UTILITY

F.   CAL BNC / Setup   *.*

Amplitude
1.00 V
into 1 MΩ

G.   *.*   *0.01V*   *.*

Frequency
1 kHz

H.   *500Hz*   *2MHz*   *.*

I.   *"Coupling"*   *DC 1M*   *(1-9*   *).*

J.   *1*   *.*

AUTO
SETUP

K.   *.*

L.
       TRIMMER   *.*

ProBus

A. LeCroy ProBus

        .

B. ProBus   *.*

   -   *,*   *. ProBus ProBus*
   EPROMS
       .

C. WavePro
   BNC   *. ****

           .

         :
WavePro DSO   **Ext BNC**
         .

✧   */*
✧   **(Trigger Out)**
✧
         (Trigger Rdy)

---

§ § §
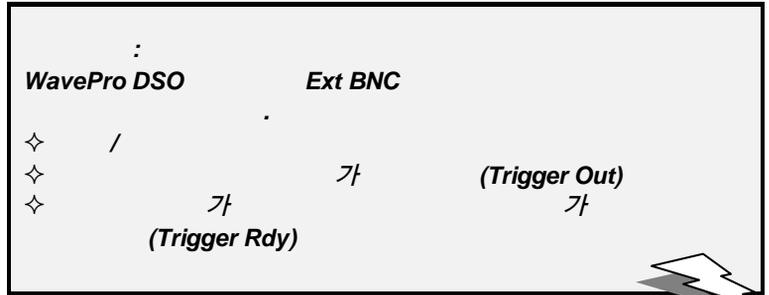
2 :

                                         .

✧

✧

✧

✧   ,

✧   *Window*

✧

WavePro DSO   .

                                    . :

✧ **Edge** – *Positive*   *Negative*   .

✧ **SMART Trigger®** -   .   *8*   *"Trigger Smart"*
     .

                                    ,   SMART Trigger   .

DELAY

:   **HORIZONTAL**   DELAY   .

                              0%   100%   . DELAY   0.1
          10,000   post-   .

          .

Post-

                              .

TRIGGER LEVEL

:   **TRIGGER**   LEVEL   .

                                                        .   ,
                    .

                                        .
          DC   .
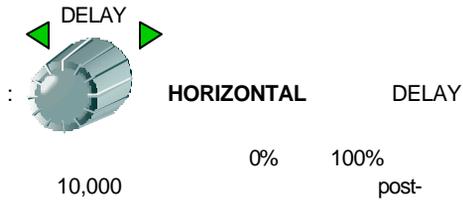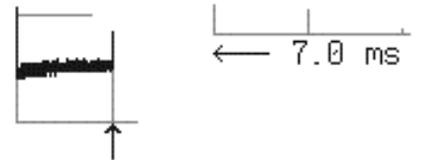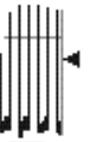
SETUP

1. TRIGGER SETUP .

TRIGGER SETUP , , (Positive, Negative)
.

Edge SMART **:**
.

trigger on
1 2 Ext Ext10
Line

3. , WavePro DSO
EXT BNC .

coupling **1**
DC AC LFREJ
HFREJ HF

4. .

5.
.

slope **1**
Pos Neg
Window

Window
. 2-5 .

. **Time** **Events**
. **Off**
. 8 "SMART Trigger" .

holdoFF
1.50 µs
OFF **Time** Evts

DELAY

6. DELAY .

TRIGGER LEVEL

7. TRIGGER LEVEL .

,

.   ,

.   .

.:

♦   ± 5V
♦ *EXT*   ± 0.5V
♦ *EXT/5*   ± 2.5V
♦ *LINE*   (   )

Coupling   .

.   .

.

DC: AC

.

♦ **AC:**   DC
10Hz   .

♦ **LF REJ:**   *High Pass Filter*
DC   *50kHz*
.   .

♦ **HF REJ:**   *DC*   *Low Pass*
Filter   50kHz
.

♦ **HF:**
. *HF*
SMART Trigger
AC   .

Positive Slope

Trigger level
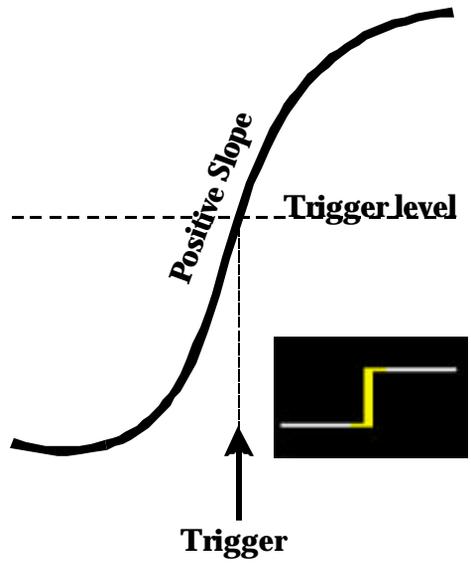
Trigger

.   2-1.

.   .   (

Positive)

.   .

AUTO, NORMAL   SINGLE   .
*STOP*   .

AUTO

○   *AUTO*   .   .
              WavePro DSO   NORMAL   .

NORMAL

○   *NORMAL*   .
                                                              .

"SLOW TRIGGER"   .

SINGLE

○   SINGLE   . WavePro DSO
              .   .

STOP

○   AUTO, NORMAL   SINGLE   . STOP
                                                                                    .

.   .
    .   .
    .

            0.008V   50ns   Positive
        .

Windows

Window   (2-2)
　　　.
　　　.   .
                    0.5ns   .

```
┌─slope 1────┐
│ Pos   Neg  │
│ ▐Window▌   │
└────────────┘
```
1.   .

```
┌─window size─┐
│ +- 67.0mV   │
│ around level│
└─────────────┘
```
2.   .

                                                            .

2-2 : Window   :   .
                                                                    .

.
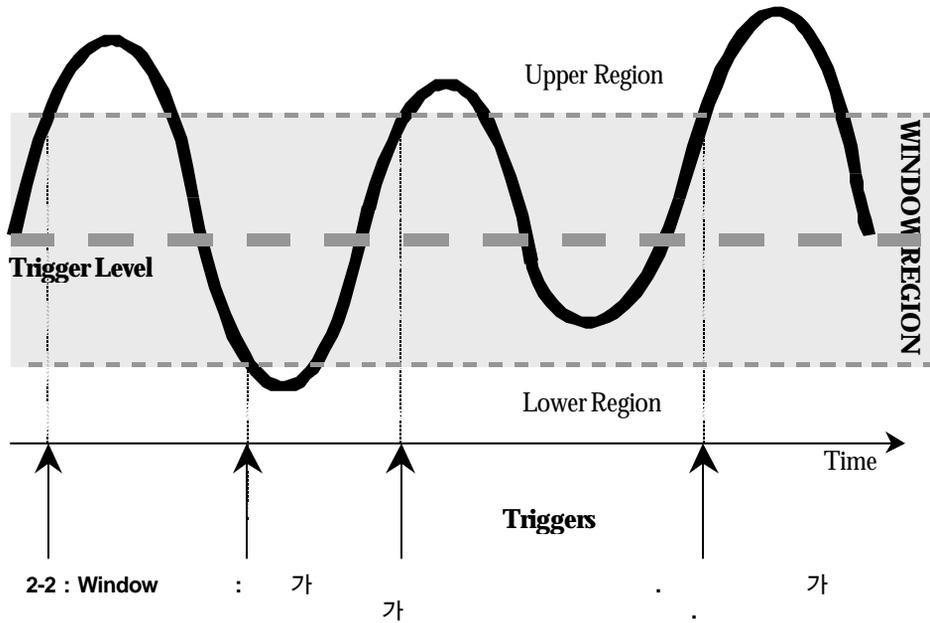
✧   ,   *(CH1, CH2, CH3   CH4)*

✧   *(LINE).*

            .   .

✧ *EXT BNC*   *(EXT).*   *EXT*   *± 0.5V*   *EXT/5*
   ± 2.5V   *.*

          ,   .

                   .

              .

✧   .

✧   *± 5*

✧ *EXT/5*   *± 2.5V*

✧ *LINE*   *(*   *)*   *.*

          :

                  .

, ,

.

SCOPE STATUS

PRINT SCREEN

1. STATUS .

:

.

2. **Acquisition** .

PANELS

. (3)
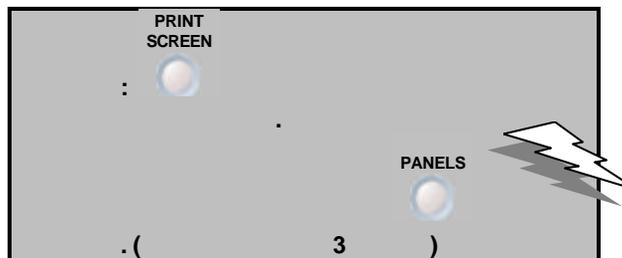
```
7-Aug-00                                              STATUS
7:07:05
                     ACQUISITION STATUS
                                                    ┌──────────────┐
                 1          2          3        4   │Acquisition   │
Vertical                                            │System        │
     V/div       5 mV       2 mV       50 mV    50 mV│Text & Times │
     Probe        ×1         ×1         ×1       ×1  │WaveForm     │
     OFFset     0.0010 V    0.0mV     0.0750 V  -0.0750 V│Memory Used│
     Coupling    AC1MΩ      AC1MΩ      AC1MΩ    AC1MΩ└──────────────┘
     BW Limit     OFF        OFF        OFF      OFF


Time base
     Time/div      10 ns       Time/pnt 250 ps (  4 GS/s)
     RIS OFF
     Sequence OFF                         Pts/div      40


Trigger  Edge   Mode   AUTO
     External Attenuation ×1


     ___┌─      1  DC 8.2mV


     Pre-trigger Delay    10% (10 ns)


                                                         4 GS/s

                                                   □   AUTO
```

SCOPE STATUS   WavePro DSO

.

Edge   SMART   8 "SMART   "   .

3 :

                                     .

   ✧

   ✧

   ✧

   ✧

   ✧

WavePro DSO   .

    1, 2, 4   8   8   (   ).
         .   .   Full Screen   .

                                          WavePro DSO   .
                                              . —   , —
                                                                                                     .

Persistence   . WavePro
DSO
"   "   .

                                                          :

**ANALOG
PERSIST**

1. ⬤| Analog Persistence   Color
    Graded   .

DISPLAY
⚪
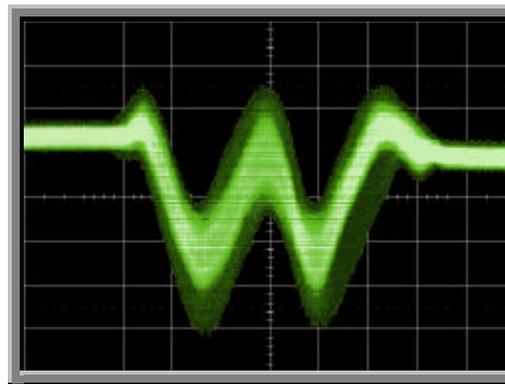
2. ⚪   "Display Setup"   .

                              1-4   (1)   .
         .

┌───┐
│   **HISTORY**   │
│   ⚪   │
│   *:*   *Analog Persistence* │
│   *.*   │
└───┘

DISPLAY SETUP

Standard
XY

─Persistence─
OFF   On
(Infinite)

Persistence
Setup

More Display
Setup

──Grids──
Single Dual
Quad Octal

──For trace──
1 2 3 4 A B C
D All

─saturate at─
50.0 %
(toggle zero)

3.

XY   . **Standard**   .

**ANALOG
PERSIST**

.   .
(   ). Persistence
Off   Dot Join   .
.   9   "
"   .
. 3-4   .

.
W'form + Text
.
. 100%
.
(
).
.

:
0%   .

PANELS   .

.   .   0%
.
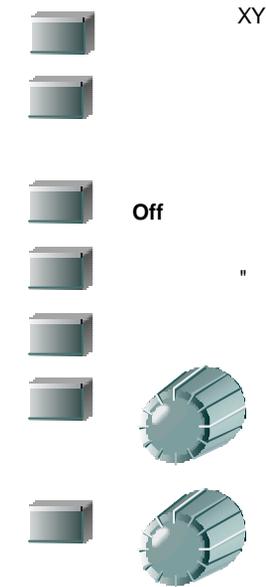
4. DISPLAY SETUP   **Persistence Setup**   .

PERSISTENCE

5.   .

Last Trace
(show)
OFF   On   .

Persist For
0.5 s   1 s
2 s   5 s   .   1s
10 s   20 s   .
InFinite   (1   )   .
                                      Infinite   .

Persist   **Analog**   **Color**
All traces   **Grade**d   .
Top 2   .

Using
Analog   .
Color Graded

For trace
1 2 3 4 A B C
D All   .

saturate at
50.0 %
(zero toggle)

6.   .

:

CLEAR
SWEEPS

.
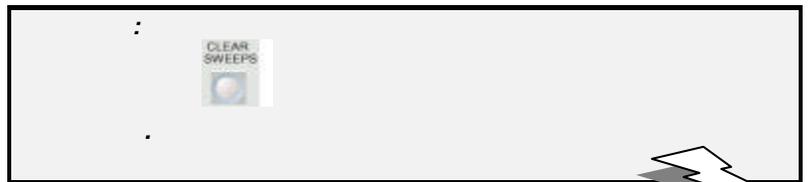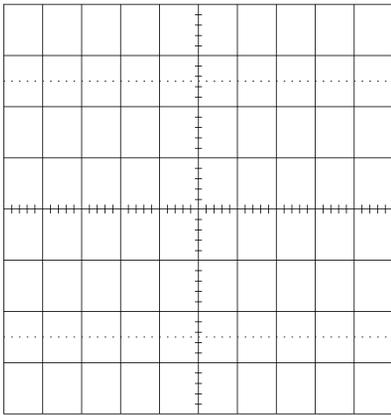
Standard
XY

1, 2   4   **Standard**
. WavePro DSO
,   6   8
6   8   (
).   (FFT
)   .   **XY**
.

Grids
Single Dual
Quad

(9   "   "   ). **Parame**te r

(4   )

Standard
XY

,   ,

.

.

.

.   ,

-

.

.

.

.

Grids
Single **Dual**
Quad

.   ,

.

,   ,

,

.

9   "

"   .
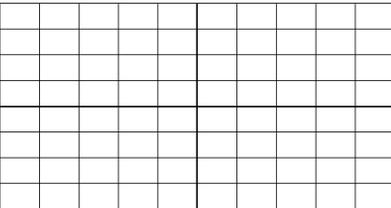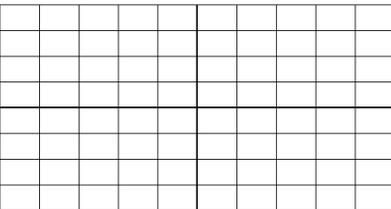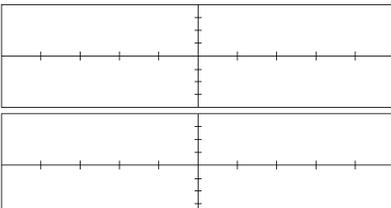
Standard
XY
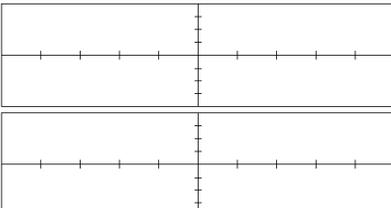
Grids
Single Dual
Quad
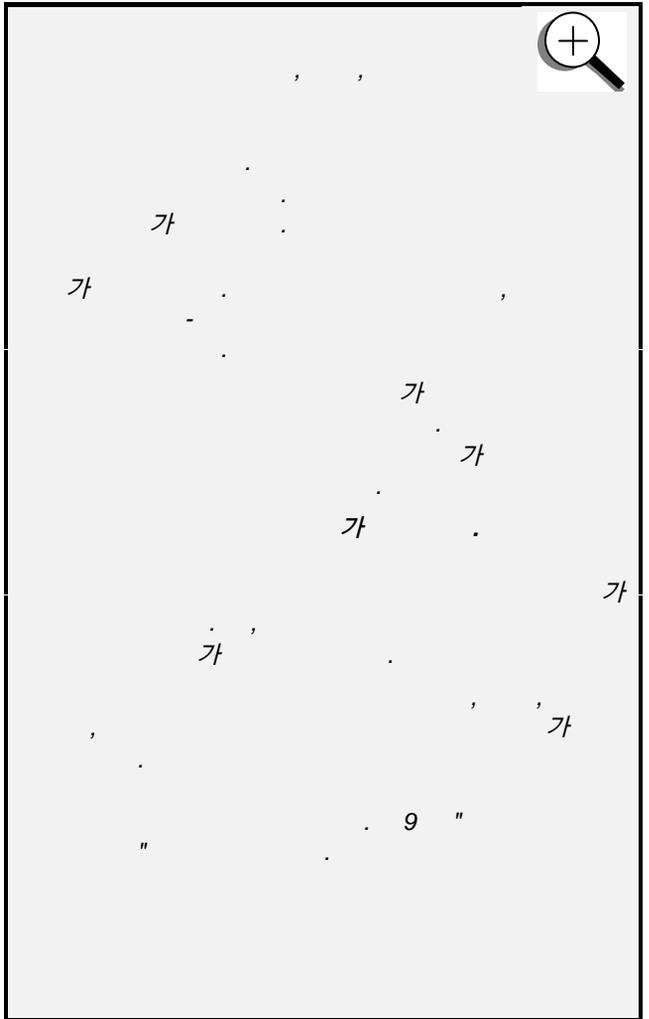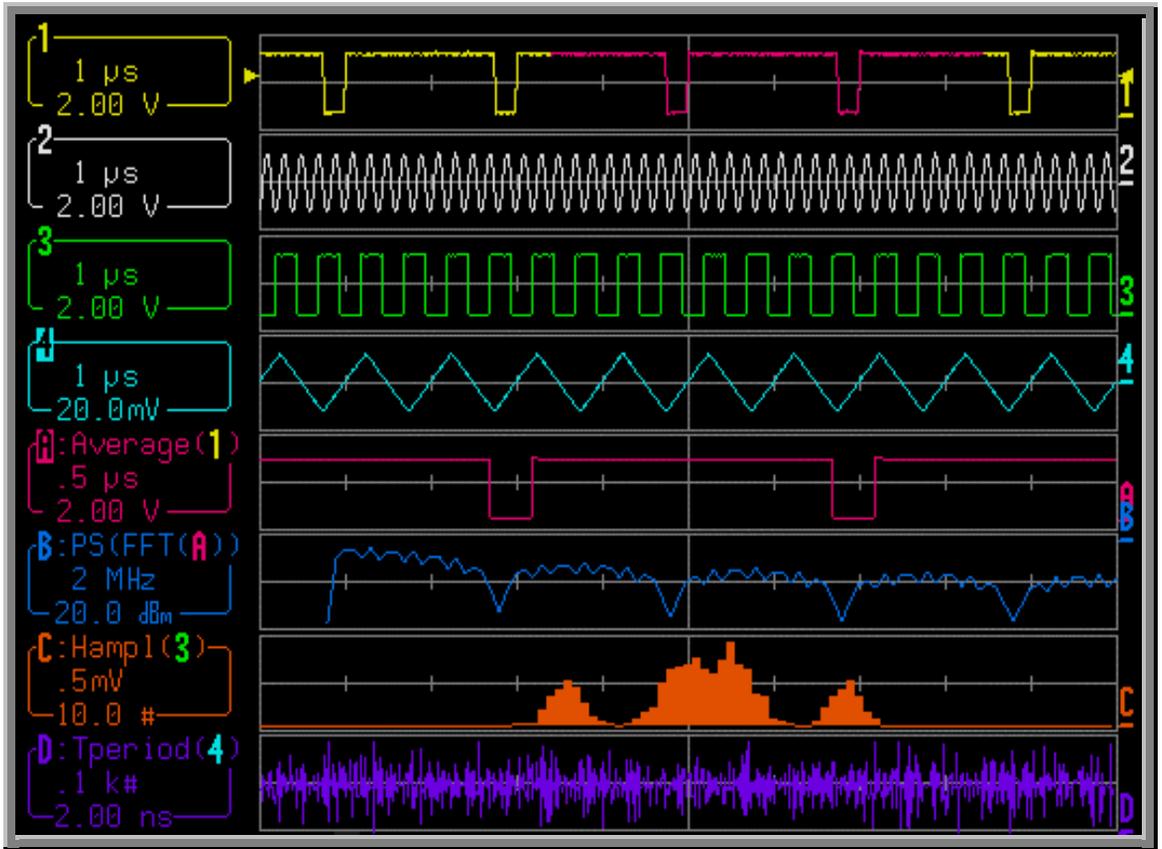
,   4   Octal   , 8
.

.
. Channel Coupling   Math Set-Up
.

Opaque   .
Transparent   .
.   9   "   "   .

.
,   .
SELECT   .
.   ,
,   (   ).   .

WavePro DSO   .
                                                                                   .
                                                                                              .

         PC Card   (   )   .
                                                                 .

PANELS

1. ⬤   PANEL SETUPS   .

                                                                                    .   SETUP1

```
┌─────────────────┐
│ PERSISTENCE     │                    .
│ ┌─Last Trace──┐ │
│ │   (show)    │ │
│ │  OFF   On   │ │      ▭▭▭      2.                    Save              .
│ ┌─Persist For─┐ │
│ │ 0.5 s   1 s▏│ │      ▭▭▭      3.                    SETUP1            .
│ │  2 s    5 s │ │
│ │ 10 s   20 s │ │      ▭▭▭                            SETUP2                .
│ │  Infinite   │ │
│ └─────────────┘ │
│  ┌──Persist──┐  │      ▭▭▭                            SETUP3                .
│  │ All traces│  │
│  │   Top 2   │  │      ▭▭▭                            SETUP4                .
│  ┌──Using────┐  │
│  │  Analog   │  │      ▭▭▭      🎛
│  │Color Graded  │
│  ┌─For trace─┐  │
│  │1 2 3 4 A B C│ │
│  │   D All   │  │
│  ┌saturate at┐  │      ▭▭▭      🎛                                        ,
│  │   50.0 %  │  │                                                    .
│  │(zero toggle) │
│  └───────────┘  │
└─────────────────┘
```

1.   ┌──choose──┐
        │ **Recall** (or) │   .
        │   Save   │
        └──────────┘

2.   ┌─FROM SETUP3─┐   SETUP1   .
        │ 27-DEC-2000 │
        │ 07:19:29   │
        └─────────────┘

        ┌───────────────┐
        │ FROM DEFAULT │
        │   SETUP   │
        └───────────────┘

     .

   PC Card,
   ┌─────────────┐
   │ From Card   │   .
   │ or Flpy   │
   └─────────────┘

                                         RECALL SETUPS   .

                        5   **"**   **"**   **.**

4   :

                          .

✧
✧
✧
✧

✧ *(   )*

✧ *( )*

CURSORS

1. Wavepilot   Cursors   MEASURE   .

2.

```
┌──mode──┐
│ Time   │
│Amplitude│
└────────┘
```
.

3.

```
┌──type──┐
│Relative│
│Absolute│
└────────┘
```
.

4.
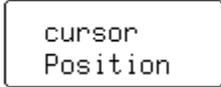
```
┌─────────┐
│ cursor  │
│Position │
└─────────┘
```
Absolute Time   .

.

.

5.
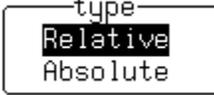
```
┌──type──┐
│Relative│
│Absolute│
└────────┘
```
.

6.   Relative Time   ↑ ↓   .

             . Relative Time   Reference
(   )   ,   .
          . Difference   (   )
          . **Diff-Ref**   .

```
    ┌──mode──┐
    │  Time  │
1.  │Amplitude│
    └────────┘
```

.

```
    ┌──type──┐
    │Relative│
2.  │Absolute│
    └────────┘
```

.

> *: Track "On"*
> *Reference Difference*
> *.*
> *. Difference*
> *.*
> *.*
> *Track "Off" .*

```
3.  ┌──────────┐
    │ cursor   │
    │ Position │
    └──────────┘
```

Absolute amplitude ▬ ▪ ▬ ▪ ▬ ▪ .

.   (   )

.

```
4.  ┌──type──┐
    │Relative│
    │Absolute│
    └────────┘
```

Reference   Difference   .

```
5.  ┌─Reference─┐          ┌─Ref + Diff─┐
    │  cursor   │          │  cursors   │
    │Track OFF On│         │Track OFF On│
    └───────────┘          └────────────┘
```

Reference   .

```
6.  ┌──────────┐
    │Difference│
    │ cursor   │
    └──────────┘
```

Difference   .

Relative Amplitude   Reference   .

.   Difference   .
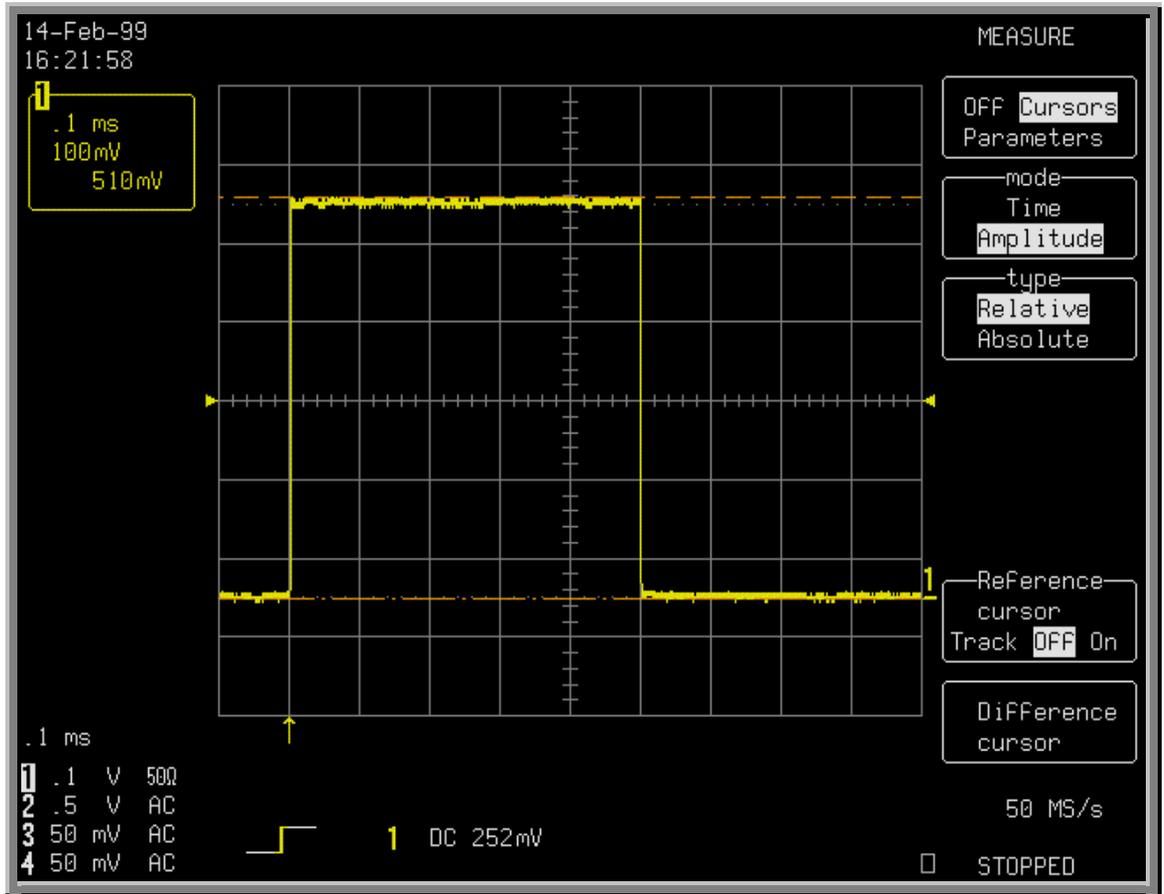
Relative Amplitude . *501mV* ,
.

Amplitude*(Voltage)* ( )
. .

Time*(Frequency)* ( )
. (�
. ⌐ ⌐)
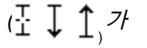
. *Relative* .
.
.

Absolute . (
) ( ) .
.

Relative .

Standard
.

:

UTILITY

, *Special*
. *Cursors Measure*
Read time _____
.

. , rms
. ,
.
. Custom 9 .
. , ,
. 11 " " .

A 50 μs 150mV   2 .5 ms 200mV   B 50 μs 150mV   C 2 μs 100mV

```
ampl(2)              428mV
pkpk(A)              856mV
mean(B)             -87.2mV
Freq(C)    ЛЛ    3.42579 MHz
maximum(2)           467mV
```

STOPPED

.(
). . :
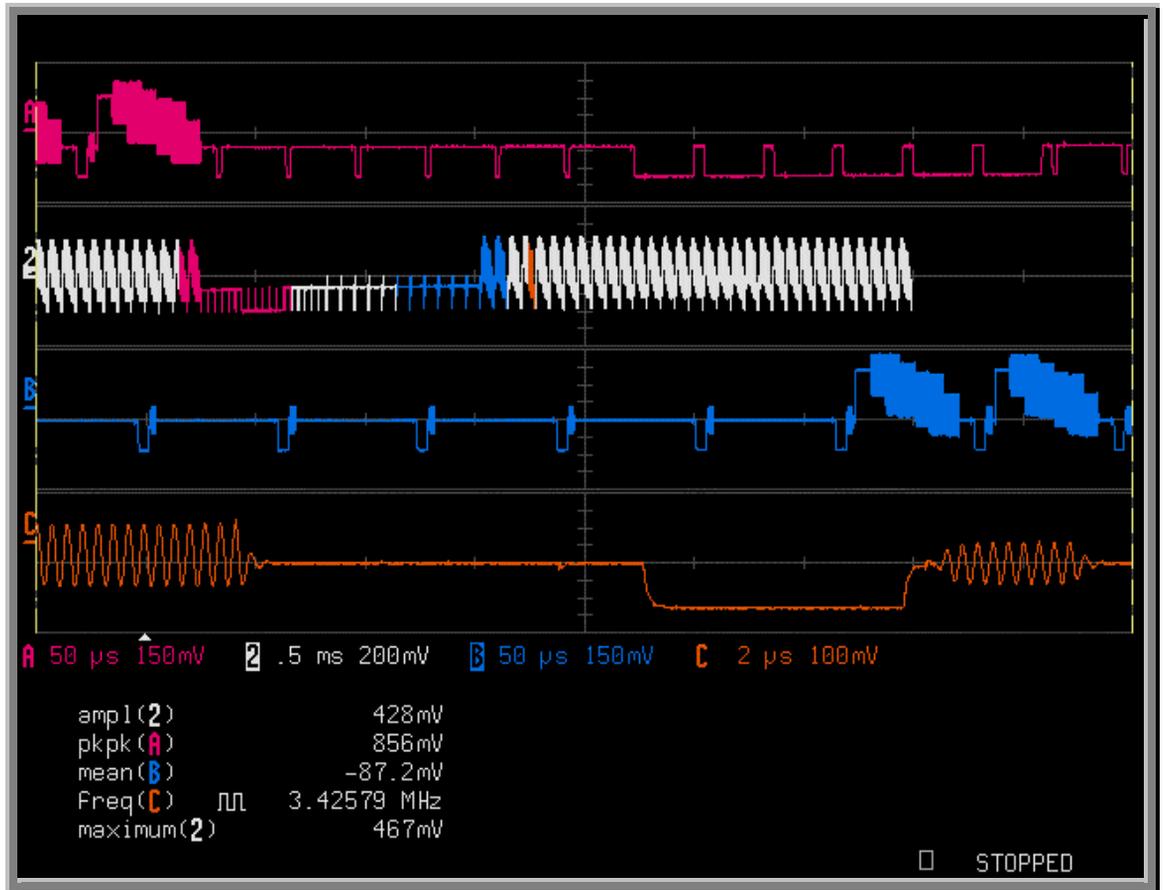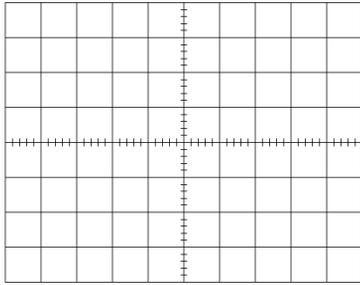
pkpk(**1**)
mean(**1**)
sdev(**1**)
rms(**1**)
ampl(**1**)

1. 　MEAUSRE　　　　　　.

OFF
Parameters

2.　　　　　　　　　　　　　　　.

"mode"　　　**Dashboard**　　　　　　　. Dashborad
　　　　　(　r 　　　　　　　　　　　　)
　　　　　　　　　26　　　　　　　.
　　　　　　　　　　　,　　　,　　　　,　　　　.
　　　　　　　　　　　,　　　,　　　　.

3.　　　　　　　　　　　　.

MEASURE

mode
Std Voltage
Std Time
Custom
Dashboard

statistics
OFF　**On**

on trace
1

from
0.00 div
Track OFF **On**

to
10.00 div
400 pts

.

. **Standard Voltage**
　　　　　.　　　　(　　　　　　　　　　　　),
　　　　,　　　　,　　　　　　　　　　. Standard
Time　　　　　　　.　,
50%　　　　,　　10-90%　　　　,　　90-10%
　　　　　　　50%　　　　　　." 　　　　",
" 　"　" 　"　11　　　　　.　　　,　　　　.
　　　　　　　　　　　　　　.

Track　　　　.

DISPLAY

4. ⬤   .   DISPLAY SETUP
          .   3   .

: ① ② ③ ④

.

MEASURE

1. ▭   MEASURE   .

OFF
Parameters

2.   .

CLEAR
SWEEPS
⬤

:   "   '
.

WavePro DSO -
.

.

.   .

                    (100)   .

                                           .

                                        .

                                   .

                           .
                            .

                    (   ).

                           .

                           .

                                .

5   :Math

.

✧ **Math**
✧
✧ **FFT**
✧
✧
✧

MATH

WavePro DSO   Math   math   (M1, M2, M3, M4)
                .   math   A, B, C   D   .

        , Trace A   1   2   , Trace B   A   , Trace C   B   .
        1   2   Trace A   .
            .   Trace A   1   , Trace B   A   FFT, Trace C   B   .

WavePro DSO   .:

	Arithmetic	Sum(add), Difference(subtract), Product(multiply), Ratio(divide)
STANDARD MATH *WavePro*	**Averaging**	Summed(linear) Average of up to 1000 sweeps
	Extrema(envelope)	
	FFT	Fast Fourier Transform to 50,000 points; Power Spectrum, Phase, Magnitude; All FFT Windows
	Functions	Identity, Negation, (Sin X)/x, Absolute Value, Derivative, Exp(base e), Exp(base 10), Integral, Log(base e), Log(base 10), Ratio, Reciprocal, Square, Square Root
	Resample (deskew)	
	Enhanced Resolution(ERES)	
	Trending Track View, Histogram(200 values max)	
WAVEANALYZER OPTION (WAVA) *Extended Math* :	**Averaging**	Summed, or linear, Average of up to one million waveforms; Continuous Average
	FFT+	Fast Fourier Transform to 25 million points or max acquisition memory, whichever is smaller; FFT Average; Power Averaging, Power Density, Real, Real + Imaginary
	Histograms	Histograms, Histogram Parameters

Mathematics

WavePro DSO   (1)   .

1. (1)   1   WavePro DSO   .

2. | ZOOM | .

3. (A)   Trace A   1   .

4. | SETUP | .
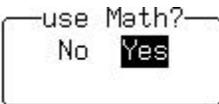
5. ┌─use Math?─┐
       │ No **Yes** │   SETUP OF A   .
       └───────────┘

MATH

MATH TOOLS
(○)

A.   ZOOM + MATH   .

B. | REDEFINE **A**
        | **A**=1 | .

C. ┌─use Math?─┐
       │ No **Yes** │   .
       └───────────┘

┌─────────────────────┐
│   :   │
│   │
│   . │
│   *MATH*   │
│   │
│   . │
│   ═   │
│   ═   │
└─────────────────────┘
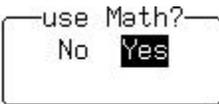
D.   .
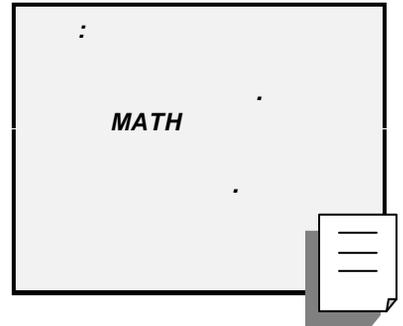
Math

　　　　　　　　　　Math　　　　　　　　　　．　　　　　　　Products　　　　　　1　　　2
　　．

```
┌─────────────────────────┐
│   SETUP OF A            │
│  ┌─use Math?─┐           │
│  │  No  Yes  │           │
│  └───────────┘           │
│                          │
│  ┌─Math Type─┐           │
│  │ Arithmetic│           │
│  │ Average   │           │
│  │ Correlate │           │
│  │ Enh.Res   │           │
│  │ Extrema   │           │
│  └───────────┘           │
│                          │
│  ┌───────────┐           │
│  │ Sum       │           │
│  │ Difference│           │
│  │ Product   │           │
│  │ Ratio     │           │
│  └───────────┘           │
│  ┌───of──────┐           │
│  │ 1 2 B C D │           │
│  │ M1 M2 M3 M4│          │
│  └───────────┘           │
│  ┌──times────┐           │
│  │ 1 2 B C D │           │
│  │ M1 M2 M3 M4│          │
│  └───────────┘           │
└─────────────────────────┘
```

Math　　　　　　　　　　．

1.　Arithmetic　　　　　　　．

2.　Product　　　　　　．

3.　　　　　　　　　　　1　　　　　　　　　　　　．
Arithmetic　　　　　　　　　operand
　　　　　　．　　　　　　　　　　　　，
DC　　　　　　　　　　．

4.　　　　　　　　　　　　1
　　．

FFT(Fast Fourier Transform)　　　　　　　　　．(　　　　　　　)

FFT

FFT   1   . FFT   RF
                                .   Time Span
            WavePro DSO   FFT   Time Span
      (10   "   Math   "   ).

1.   Math Type   **FFT**   .

0   Nyquist
                .   (Hz/div)   1-2-5   .
FFT
          .

$\diamond$ *N(   )*
$\diamond$ *Nyquist   (-½   )*
$\diamond$ *? f*

                                    . Nyquist   = ? f*N/2,   ? f=1/T, T
      (10*time/div)   .   N/2   .
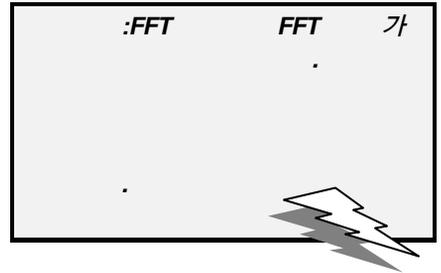
```
┌─FFT result─┐
│ Phase      │▌
│ Power Dens │
│ Power Spect│
│ Real       │
│ Real+Imag  │▐
```

2.   Power Spectrum   .

Power Spectrum   . 0 dBm   50w   1mW
      (0.316V   )   . Power Spectrum   (dBm)   .
                        FFT   WavePro DSO math   (5-
1   ).
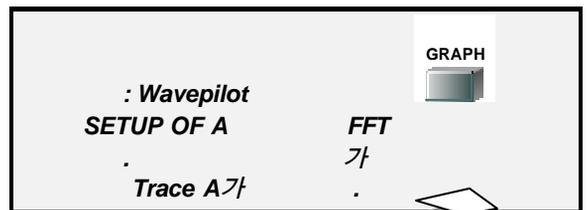
Phase 0 .
-90° . .

Power Density: FFT .
. Power Density dBm . WavePro DSO WaveAnalyzer
.

Magnitude: .

Real, Real + Imaginary, Imaginary: FFT .
WaveAnalyzer .

```
┌─with window─┐
   Von Hann
   DC  ▉▉
└─────────────┘
```

3. Von Hann **AC** .

AC DC FFT 0 . DC
.

FFT FFT . (10 " Math "
.)

Von Hann(Hanning) . .

Rectangular ( ) . Rectangular
.
.

Hamming .

Flat Top , .

Blackman-Harris .

4. FFT .
FFT " " " " .
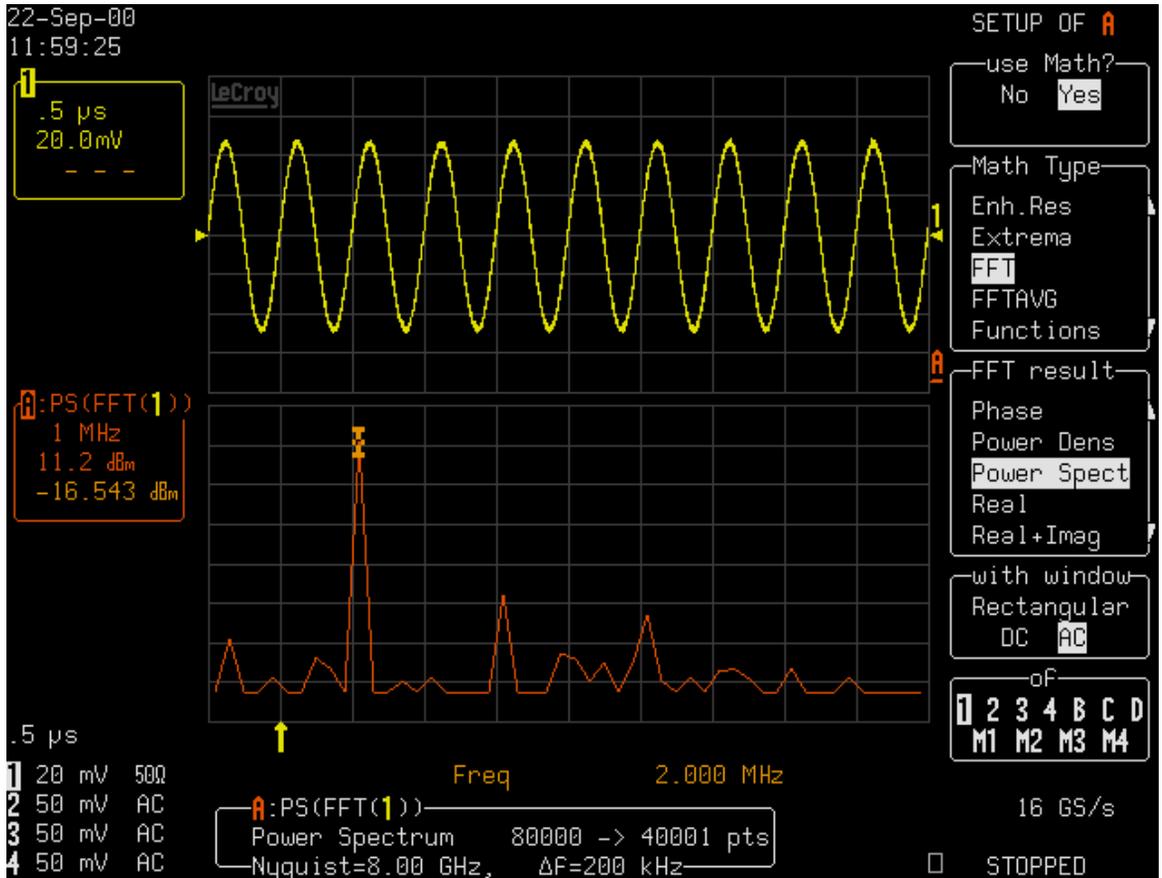
FFT Power Spectrum : FFT Power Spectrum

.   *. Trace*
A   *1MHz*   .   *FFT*
              .

Summed Average   .   .

1.   Math Type   **Average**   .

2.   .

                            .   .

                    .   .
    (   )   .

WavePro DSO   .

3.   .   (4000   )

                                        .

            Continuous Average   "for"   "with…weighting"   .
                                    .

(10   "   Math   "   .)

4.   .

                                        .

: *.*
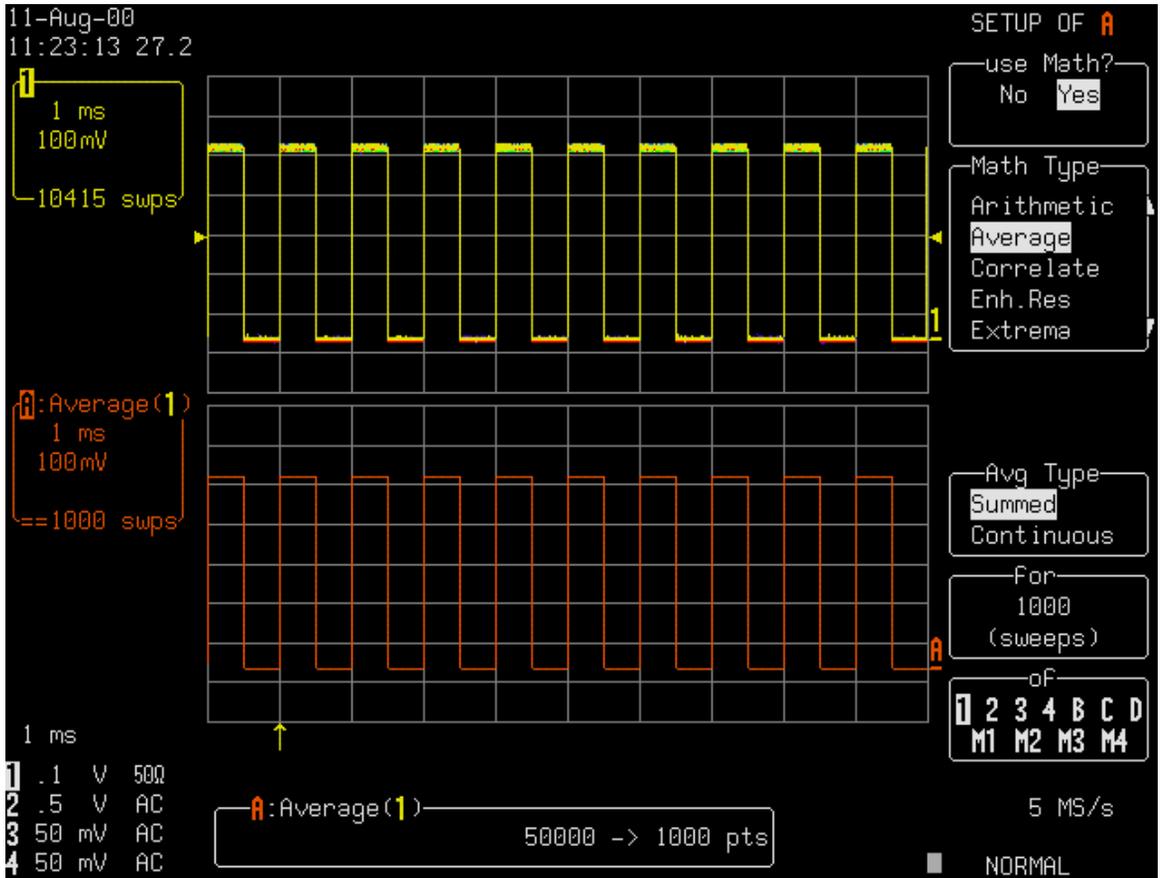
1000 *.* *(1000)* *.*

(50,000 -> 50,000) *.*

**MATH
TOOLS**

MATH TOOLS

```
─For Math use─
 max points
    50000
```

.

(M1, M2, M3   M4)   PC Card   (HDD)
.   .
.

**WAVE
STORAGE**

1.

Store
WaveForm   .

STORE W'FORMS

2.   .

.(   )

.

,
.

DO STORE
(1->**M1**)

store
1   2
3   4
A   **B**
C   **D**
All displayed

to
M1 M2 M3 M4
Flpy

ASCII   12   "WavePro
? ? ? *c*? ? ? ? ? *c*? ? ? ?

6 :

.

? WavePro DSO

?

? TIFF BMP

? , PC
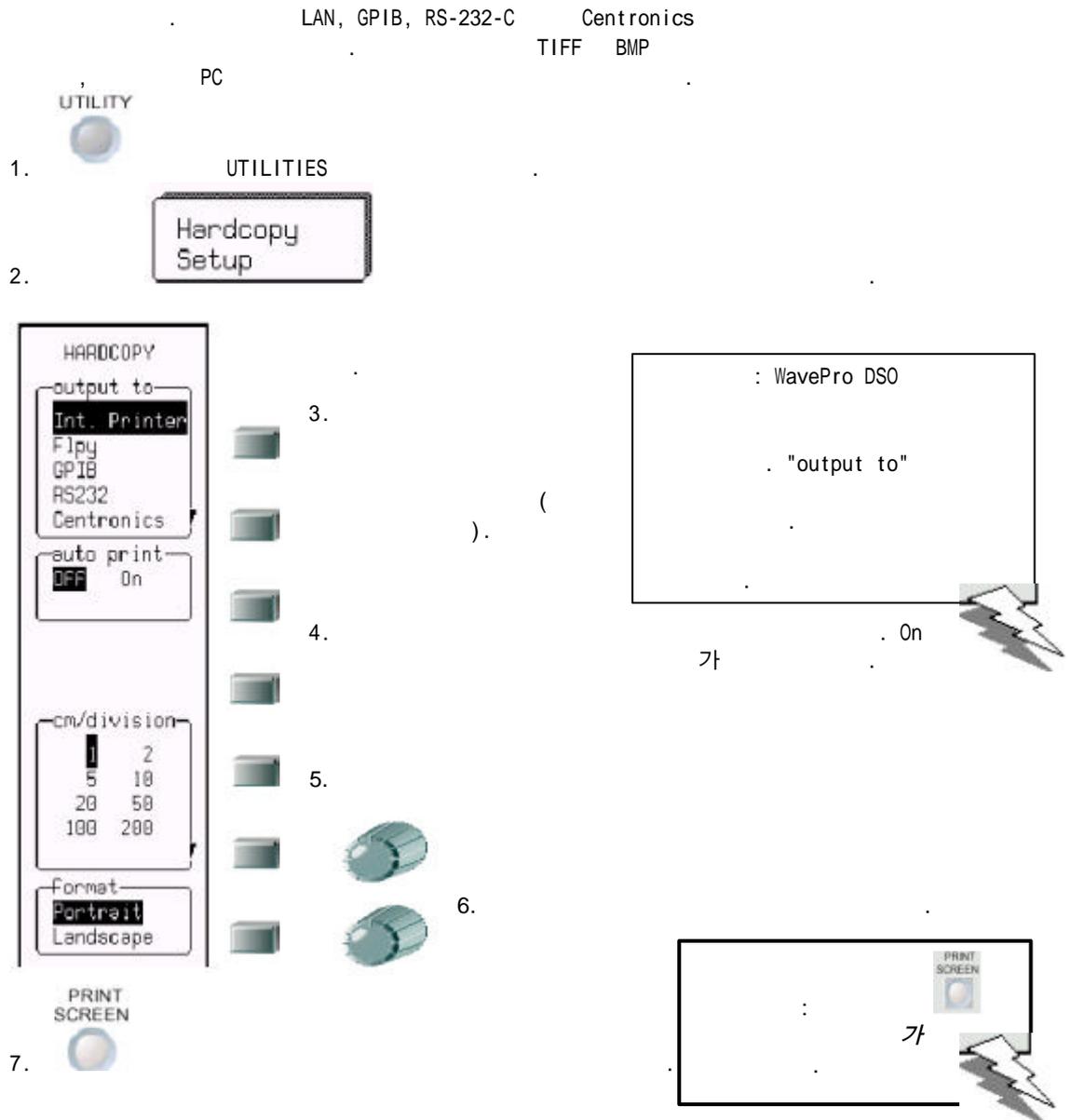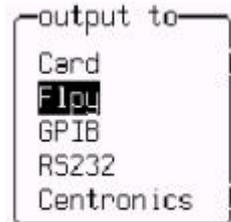
?

?

?

. LAN, GPIB, RS-232-C Centronics
. TIFF BMP
, PC .

UTILITY

1. UTILITIES .

Hardcopy
Setup

2. .

HARDCOPY

output to
Int. Printer
Flpy
GPIB
RS232
Centronics

3

: WavePro DSO

. "output to"

auto print
OFF On

4

( ).

. On

cm/division
1   2
5   10
20   50
100 200

5.

Format
Portrait
Landscape

6. .

:

PRINT
SCREEN

PRINT
SCREEN

7. . .

![wavepro logo]

,

1. , PC Card
.

2. , (TIFF, BMP
HPGL) .

```
printer
EPSON col
LaserJet
DeskJet col
DeskJet b/w
HP 7470
```

```
output to
Card
Flpy
GPIB
RS232
Centronics
```

. "plot size" "pen number"
. TIFF BMP
"background" .
. WavePro DSO
(6-5).

```
page feed
OFF On
```

3. 4
.

PRINT
SCREEN

4. ,
, .
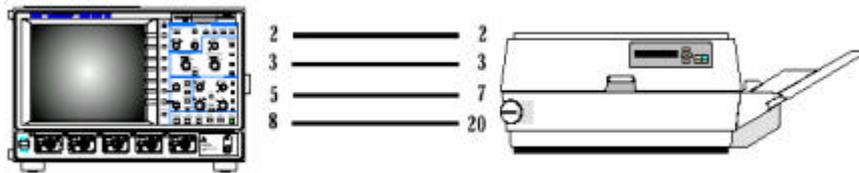
6-1. RS-232-C : RS-232-C
. GPIB PC
RS-232-C .
12 "PC WavePro DSO " .

LeCroy ....

                                                    Net Setup ....

```
HARDCOPY
output to
HDD
GPIB
RS232
Centronics
Net Printer

Network
Setup
```

1.   Net Printer ....

2.
                              (6-2).

W wavepro

```
5-Sep-00                          Net Setup
7:35:18  1.3
                              ┌──────────────┐
                              │  SET NEW     │
   TCP/IP Network Setup       │  ADDRESS     │
                              └──────────────┘
   IP Address     172.28.11.48
   Default Gateway 172.28.8.1
   Subnet Mask    255.255.248.0
   Print Server   [172].28.14.68
                              ┌──────────────┐
   Check with your network administrator before
   choosing an IP address to avoid conflicts
   with other network devices.     │  <---   │
                              └──────────────┘
   Note that the network printing requires
   that a LeCroy Print Server is running     ┌──────────────┐
   somewhere on the network.                 │  --->   │
                                             └──────────────┘

                              ┌─Value────────┐
                              │     172      │
                              └──────────────┘


                                        2 GS/s
                                         24T x
                                    □  AUTO
```

6 2

WavePro DSO　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　PC
　　　　　　　　　　　　　　　　　　　　　　　　　　.

　　　　　　　　　　　　　　　.　　　　　　　　　　　　　　　　　　　　　　　　　　　.

UTILITY

1.　　　　　　　　　　　　UTILITIES　　　　　　　　　　.

Mass Storage Utilities

Floppy Disk Utilities

2.
　　　.

　　　　PC Card　　　　　　　　　　　　　　　　　　　　　　　　　　,

Memory Card Utilities

(RE-)READ DRIVE

3.
　　　　　　　　　　　　　.

TEMPLATE AND FORMATTING

4.　　　　　　PC Card
　　　　.

5.
　　DOS　　　　　　.　　　　　　　　(　　　　　　　　　　　　　　ASCII　　　)
　　　　　　.

6.　　　　　　　　　　MASS STORAGE　　　　　　　　　　.

Mass Storage Preferences

7.　　　　　　　　　　　　　　　　　　PREFERENCES　　　　　　　.

File Name   New Directory
.

8.   .
DELETE THIS DIRECTORY   .

File Name
Preferences

9.   .

WavePro DSO   .
.

FILENAME PREF   1.   ,   .
SC1.xxx
to be set to: (   ).
TER.xxx
File Type   (   )
RESTORE   .
DEFAULT NAME

ENTER NEW   .
FILE NAME

BACKSPACE   .

INSERT   .
                                                              (
-character-   )   .
56789.ABCDEFG
-File Type-   .
Channel 1
Channel 2

2.   PREFERENCES   .

```
Add new
Directory
```

1.   .

2.
                                                        .

```
NEW DIRECTORY
New Directory
 on Card:
DA
```
                                                                    (
).

```
MAKE THIS
DIRECTORY
```
                                                        .

                                                            .

```
BACKSPACE
```
                                        .

```
INSERT
```
                                                        .

```
character
789_ABCDEFGHI
```
                            (   )   .
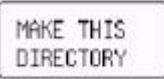
3.   MASS STORAGE
                            .

![wavepro logo]

, WavePro DSO

PC Card

( ).

File
Transfers

1. .

Direction
Card -> Flpy
Flpy -> Card
Card -> HDD
HDD -> Card
Flpy -> HDD

2 .

Which Files
Panels
Prints
WaveForms
All Files

3. .

DO COPY

4. .

WavePro DSO

UTILITIES   *Mass Storage Utilities*   *MASS STORAGE*

.   *DOS 1.44 MB*

720 kB

.

WavePro DSO

.

.   *LECROY_1.DIR*   .

.   *PC*

.

2400   .

DOS

.   . *MS-*

DOS   *8*   .

.   *PNL*   ,

,   *TPL*   ,   *TIF, BMP*   *PRT*

,   *PLT*   *HPGL*

.

	Stt.nnn	*xxxxxxxx.nnn*
	Att.nnn	*xxxxxxxx.nnn*
	Pnnn.PNL	*xxxxxnnn.PNL*
	Dnnn.TIF	*xxxxxnnn.TIF*
	Dnnn.BMP	*xxxxxnnn.BMP*
	Dnnn.PRT	*xxxxxnnn.PRT*
	Dnnn.PLT	*xxxxxnnn.PLT*
	LECROYvv.TPL	
	LECROY_1.DIR	*xxxxxxxx*
	Sttnnn.TXT	*xxxxxnnn.TXT*
MATLAB	*Sttnnn.DAT*	*xxxxxnnn.DAT*
MathCad	*Sttnnn.PRN*	*xxxxxnnn.PRN*

X	DOS	**w**	: 2 2 LECROY22.TPL .
Tt	C1, C2, C3, C4, TA, TB, TC, TD	**TIF** **BMP**	,
Nnn	001	**PRT**	
HLT	HPGL		

Stt.nnn,

Att.nnn . *S A* .

WavePro DSO .

' *Stt*' (*SC1, STB)* *AC1, ATB*

'*Att*' .

.

Fill *Axx.001,*

Axx.002 . *WavePro DSO* , 999

2400 .

Wrap

. . ,

"*Axx.001*" , "*Axx.002*"

.

, , *WavePro DSO*

.

'*nnn*'

. *WavePro DSO*

.

kbytes . 1

kbyte 1024 . *Mbytes*

. 1 1*Mbyte* 1 .

. .

WavePro DSO

"*Device is Write Protected*" .

PC **12** **"PC** **WavePro DSO** **"** .

§ § §

wavepro

2

2   **WavePro DSO**
          .   **RIS**   , **SMART Trigger, Advanced waveform**
processing   .   **1**
                 .
     2   .
             .

7 :

1 . **WavePro DSO**

.

.

?

? Single-shot RIS

?

?

, Single-shot,
RIS(Random Interleaved Sampling)   (roll mode)   .   Single-shot
Roll

.

Single-shot – WavePro DSO

Single-shot   .
Single-shot   .

.   Horizontal
Position(   )   0
.
Pre-trigger   Post-trigger   . Pre-trigger
WavePro DSO   Post-trigger
.
.   100% Pre-trigger
. (WavePro DSO   Pre-
trigger   .)   Post-trigger
10000   .
WavePro DSO   ADC(   )
.
.
Single-shot   .
.
,   .

$$CaptureInterval = 1/SampleRate?Memory$$

$$CaptureIntervaly/10=TimePerDivision$$

RIS -

RIS(Random Interleaved Sampling)   Single-shot
acquisition   .
. 50GS/s   WavePro DSO
500MS/s
100   Single-shot acquisition   RIS   .
bin   20ps   .   bins

. ADC

5ps   .

1 GS/s RIS acquisition   WavePro DSO 30   , 25
GS/s acquisition   230   .   ,
                                                          .   (7-1)
interleaves   Single-shot
                .   WavePro DSO
                        interleaving   .   4000
RIS   .

Segment 1

Segment 2

Segment 3

Final capture
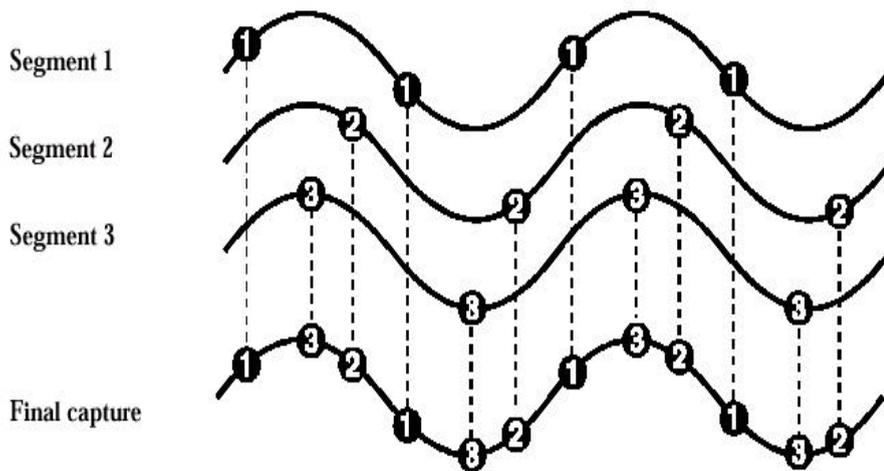
7-1. RIS

Roll –

WavePro DSO   (roll mode)   Single-shot
acquisition   Incomming Points   . 0.5 s/div
                                                    acquisition
                                              .
                    .   .
        ,   .   Math

–

Single-shot   (

7-2)   (WavePro DSO   ).

Math

.

. WavePro DSO

.

acquisition

.

1ns   Text & Times

.   Math   .

WavePro DSO   .

, 10 x time/div   .   ,

.

.

WavePro DSO

(12   "PC   WavePro DSO   "   .

7-2 WavePro DSO   .   **7**

     7   .

....

1 4 2
3 .
4 .
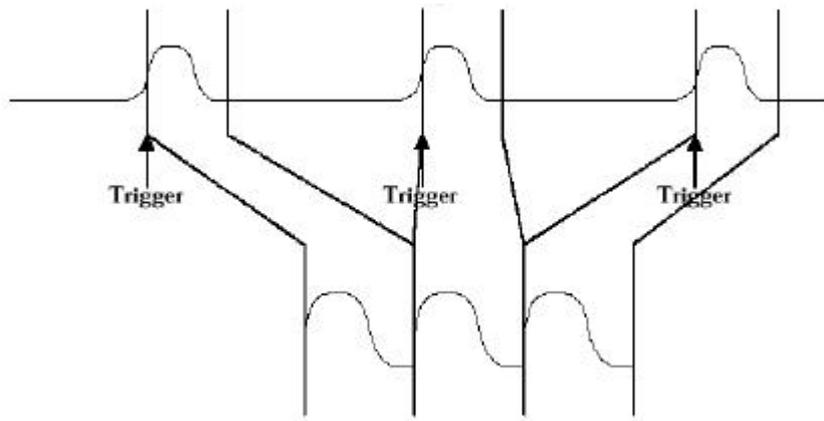
(EXT BNC)
.
"Automatic" .
Acquisition Summary "trig only"
.

A " " .

7-3
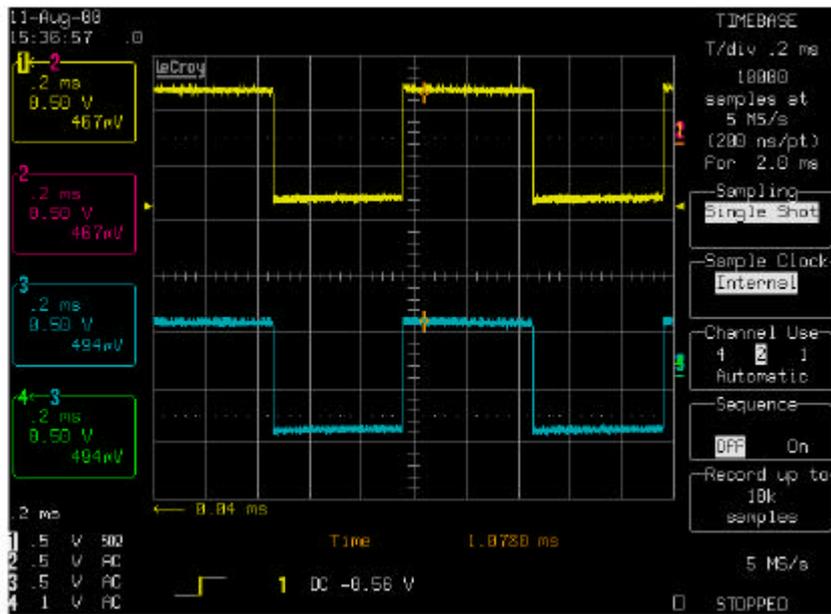
Single-shot RIS

SETUP

1. HORIZONTAL   TIMEBASE SETUP   .

2   WavePro DSO   Single-shot
RIS   .

TIMEBASE

T/div 20 ns

800
samples at
4 GS/s
(250 ps/pt)
For 200 ns

Sampling
Single Shot
RIS   Single-shot acquisitions
                                                                     Single-Shot

Sample Clock
Internal   RIS   .
ECL 0V TTL   .   7-8
                                                        .

Channel Use
4 2 1
Automatic

Sequence

OFF   On   "On"   "Off"   .
                                                                     .
Record up to   .
4M
samples   .

![wavepro logo]

```
TIMEBASE
T/div  5 μs
50 ∗ 12500
samples at
250 MS/s
(4 ns/pt)
for   50 μs
┌Sampling─┐
│Single Shot│
└─────────┘
┌Sample Clock┐
│Internal│
│ECL 0V TTL│
└─────────┘
┌Channel Use┐
│4  2  1│
│Automatic│
└─────────┘
┌Sequence─┐
│50 segments│
│OFF  On│
└─────────┘
┌Max. segment┐
│500K│
│samples│
└─────────┘
```

3.

.

SCOPE
STATUS

:   **"Text and Times"**

.

Single-Shot   .

Internal   - **ECL, 0V, TTL** –
.

(   ). UTILITIES,
Special Modes   Timebase Trigger
.

Sequence   .

.

:   : SINGLE   WavePro DSO
.
WavePro DSO STOP   . NORMAL
.
WavePro DSO   . AUTO
Time-out
.

.

---

4.   STATUS

5.   **Text & Times**

7 4   **SCOPE STATUS**
Select

![wavepro logo]

```
TIMEBASE
EXTERNAL
  1 M
samples at
100 kS/div


─Sampling─
Single Shot

Sample Clock
 Internal
ECL 0V TTL

─External─
DC50Ω DC1MΩ

─Sequence─
OFF    On

─Record─
  1M
samples
```

(   ) WavePro DSO

EXT

Single-Shot   .

EXT   .   **ECL**
−1.3V,   **0V**   0.0V   **TTL**   +1.5V   .

:   **EXT**   .
      AUTO   **Time-out**
   .   **Dead time**   .
   time/div
   .
                                          . **WavePro DSO**
                    . **WavePro DSO**
                 . **TIME/DIV**
(   )   .

§ § §

(p7-9)

8 : *SMART Trigger*

. *SMART Trigger* .

.

? *Hold off*

? *Glitch*

? *Exclusion*

? ,

? *Intervals*

? *State* *Edge Qualified*

? *lost*

? *Pattern Trigger*

? *Runt Trigger*

? *SlewRate Trigger*

Hold-off

Hold-off   Edge   (2   "   "   ). Hold-off
. Hold-off
0   .
. Hold-off
. Hold-off
.   Hold-off
. Qualified   Hold-off
(8-14   ).

Hold-off

.   ,   ,
WavePro DSO   . Positive   Negative
.

Hold-off   (8-1). 2ns   20s
.   .

Trigger Source Positive Slope
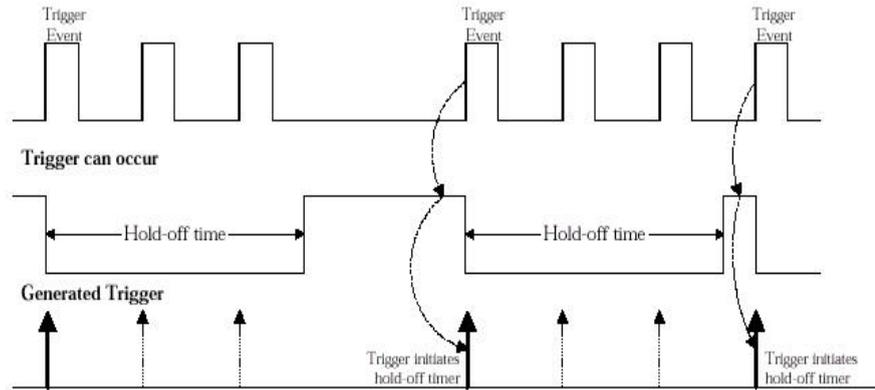
8-1.   Hold-off   Edge   Positive
.

Potential Potential   .   **Hold-off**
.

Hold-off

Positive   negative   .

                                                                   .

                                                          .

                                    .   2   (8-2)
                              . 1   99 999 999   .

Trigger Source Positive Slope

Trigger Source: Positive Slope
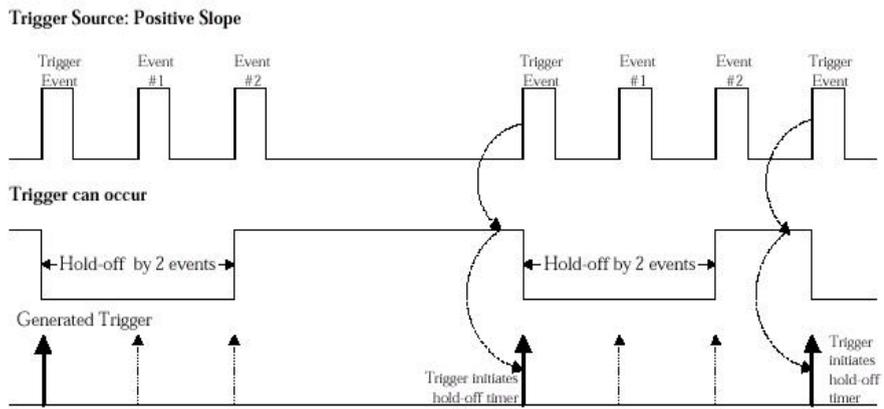
        8-2   Hold-off   Edge   (   ).
                                    Positive   .
              Potential   .   Hold-off
                                                                    .

TRIGGER SMART

Edge   ,
Hold-off   .   WavePro DSO

            . SMART Trigger   Qualification
            . Glitch(   )   Spikes(   ), Specific Logic Status(   )
     Missing bits   .   ,   TV
            . State   Edge-qualified   (dropouts)   .

Glitch

                            ,
                                    .

1.   WavePro DSO   .

2.

                    .   .

3.
                            .

4.   STOP   .
                                                                    .
                                                                    .

5.   TRIGGER SETUP   .

6.   .

SMART TRIGGER

type
Glitch
Interval
Qualified
Dropout
Pattern

trigger on
1 2 3 4 Ext
Ext5 Pattern

cplg Ext
DC AC
LFREJ HFREJ

at end of
Neg Pos
pulse

width ≤
12.4 ns
OFF On
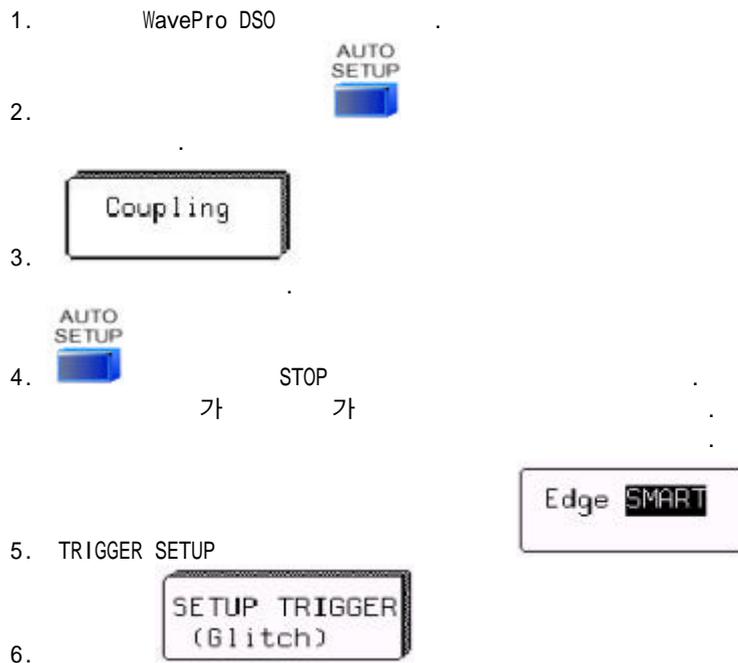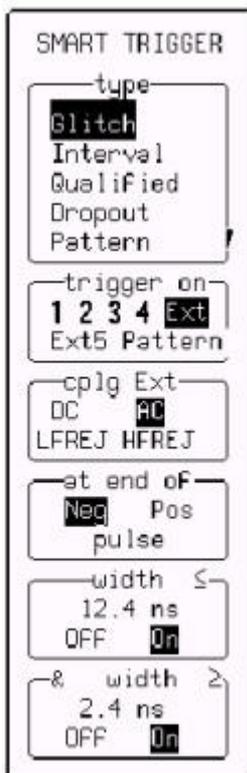
& width ≥
2.4 ns
OFF On

Exclusion   (8-7   ).

7.   Width
                    .   .
            ,   .

                    (8-7   ).

8.   ,
WavePro DSO   EXT
                    .

9.   .

10.   Positive   Negative
                    .   .

                              On

                              (: 0.6 ns ~ 20s).
"width ³"   .

                              On

                              (: 0.6 ns ~ 20s). Width
³"   "width ³"
    ("&")
"width £"   .
"OR"
                                              .

: WavePro DSO
              "   "
                    .

Negative
"Pos"   .
Positive   **"Neg"**
              .

: Persistence

              .

NORMAL
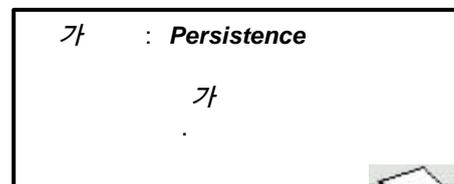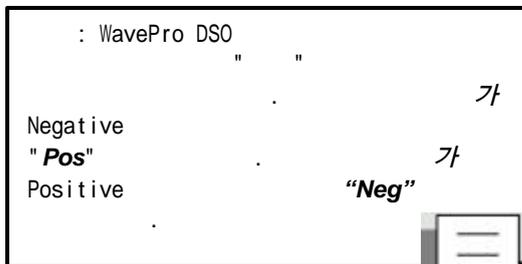
11.   ○   .

.   .

8 3 Negative   **5.0 ns**

.   **A**

.   .

> *:*
>
> . *WavePro DSO*   *DC*
>
> .
>
> .
>
> .
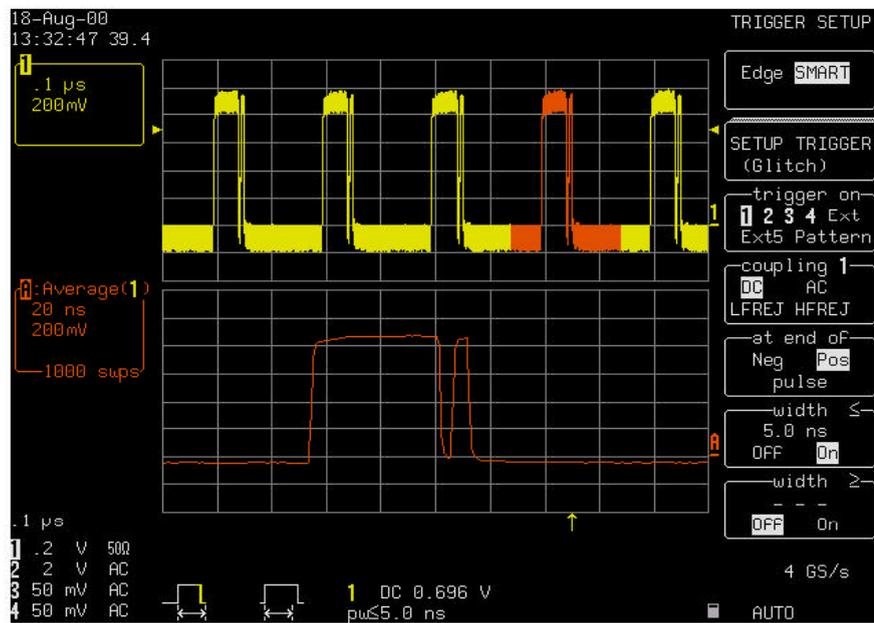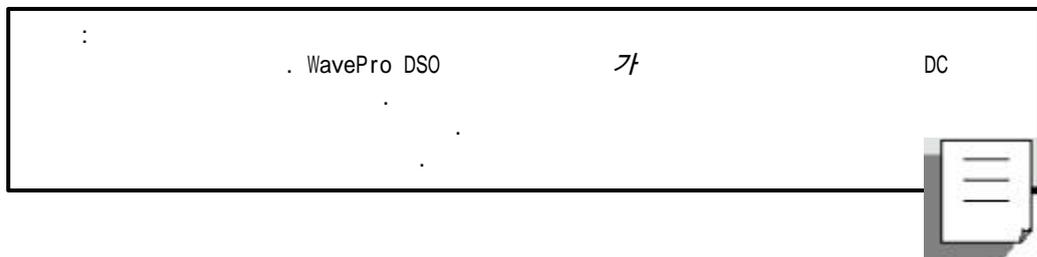
: (8-4).

.

. 600 ps 20 s .

Trigger Source

Glitch
Width

Glitch
Width

Trigger can occur

Width
Selected

Width
Selected

Generated Trigger

8 4 :
. **Potential** ,
.

.

. WavePro DSO

.

.

1.   Edge   Analog
    Persistence   1   .

2.

                .

3.   .

                                     .

                                     .

4. TRIGGER   .

5.   .

                                     . WavePro DSO

                .

6.   "trigger on"   1   .

7.   .

8.   "at end of"   Pos   "width "   On   .
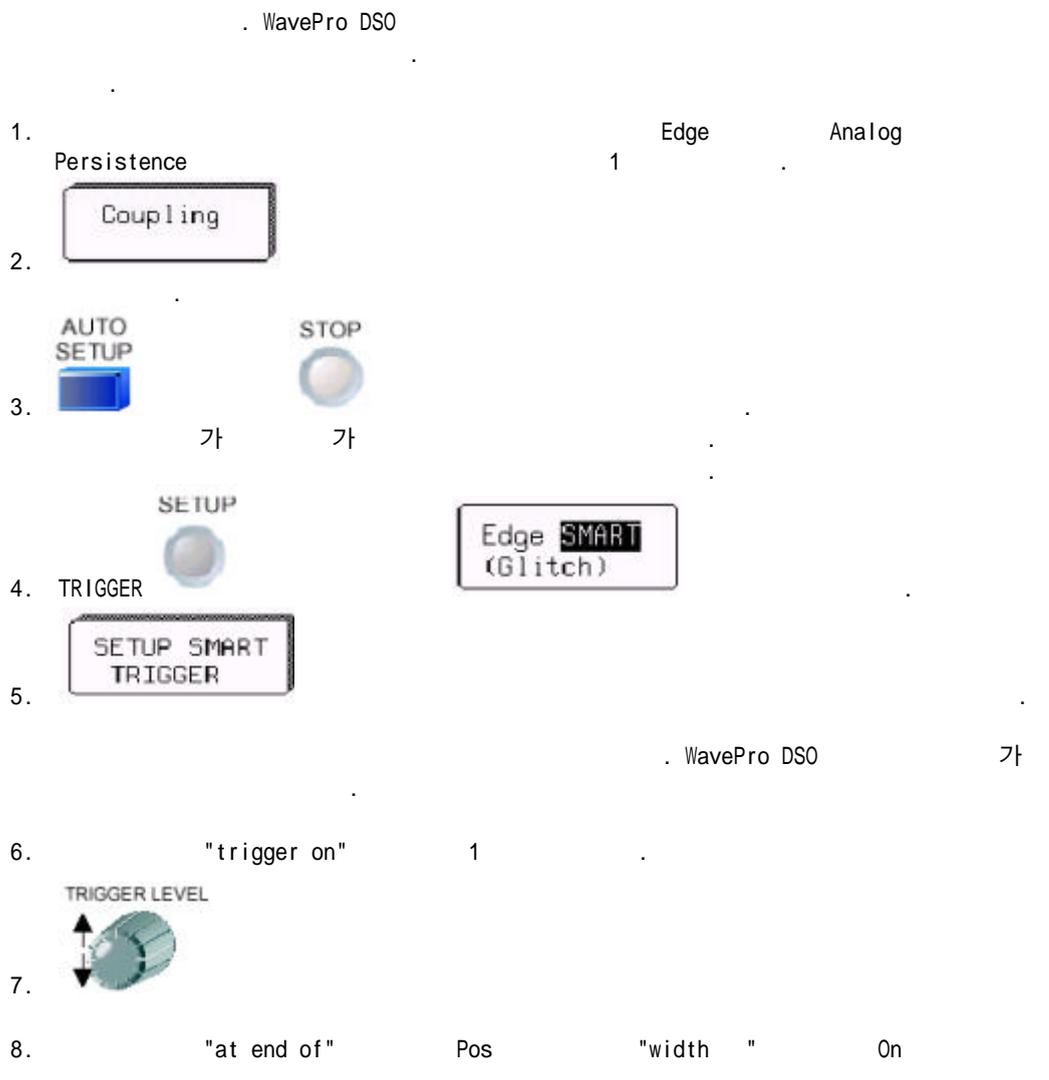
9.　　　　　£width"　　　　　.

10.　　　　　"width"　　　　On　　　　　　　　=Width　　　　　.

DELAY

11.　　　　　　　　　　　　　　　　　　　　　　.

NORMAL

12.　　　　　　　　.
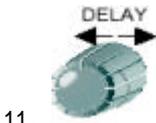
: *Analog Persistence*

History
.
Exclusion　　　*Pass/Fail*

.

.

.

.

.
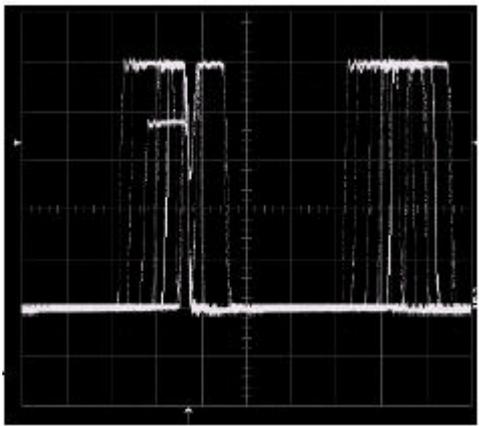
8 5 *Exclusion*　　　: *Persistence*

,

,   .

.

.

.

?   *±5*

? *EXT*   *±0. 5V*

? *EXT/5*   *±2. 5V*

? *LINE*   (   )

Coupling   .

.

.   .

? *DC:*   *AC*

.

? *AC:*   *DC*   *10Hz*   .

? *LF REJ:*   *DC*   *50kHz*

.

.

? *HF REJ:*   *DC*   *50kHz*

.   .

.

Positive   *Negative*   .

.

Interval

Interval   .
                                        .   ,   ,
                          . Interval
                                   .
                           .   ,   Exclusion   .

                                                                      .

1.   Interval   .

2.   .

3.   .

4.   Positive   Negative
                               .

5.   On
                                                   (: 2 ns
     ~ 20s). Width ³"   .

6.   On
                                                   (: 2 ns
     ~ 20s). Width ³"   "width ³"
                          ("&")
                   "width   "   .
                   OR
                                    .

I NTERVAL

　　　　　　:
Interval Trigger　　　　　　　　　　　　　　　(
　　　　)　　　　　　　　　　　　　(　　8-6).

　　　　　　　　　　　　　　　　　(　　)　　　　　　　　.
WavePro DSO
　　　.　　　　2ns　20s　　　　　　　　　.

Trigger Source: Positive Slope

Interval Width — Interval Width

Trigger can occur

Selected Interval　　　Selected Interval
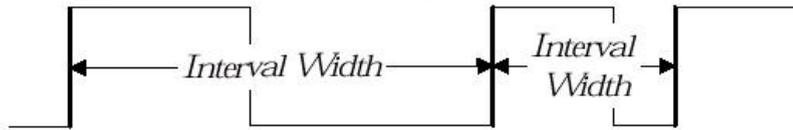
Generated Trigger

　　8-6　　　　　　　　　　　　　　　　Interval　　.
　　　　　Potential　　　,
　　　　. ,　　　　　　Positive　　.
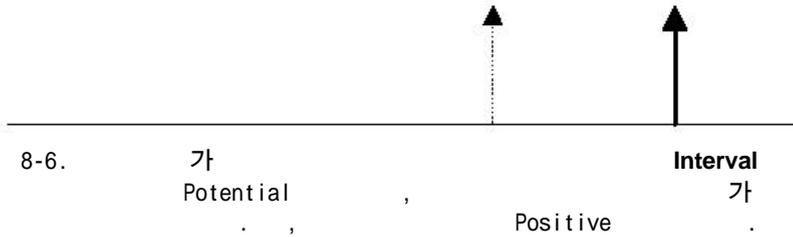
Interval Trigger
(8-7). WavePro DSO
.
.   *2ns   20s*
.

Trigger Source: Positive Slope

Interval Width   *Interval Width*

Trigger can occur

Selected Interval   *Selected Interval*
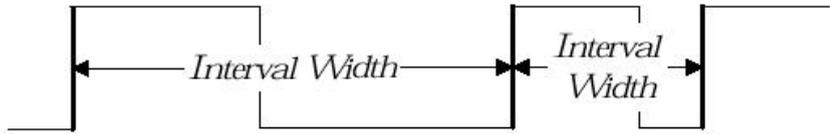
Generated Trigger

8-7.   **Interval**   .

Potential   ,
.   ,   **Positive**   .

__Interval:__ Interval Trigger

(8-8). *WavePro*
DSO
. 2ns 20s .
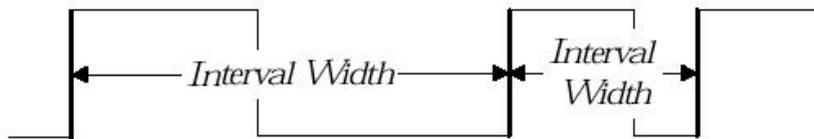
Trigger Source: Positive Slope

Interval Width   *Interval Width*

Trigger can occur

Range   *Range*

0   T1   T2   0   T1   T2

Generated Trigger

8 8   Interval   . T1 =
   ; T2 =   **Potential**   ,
             . ,   **Positive**
        .

Qualify

(   )
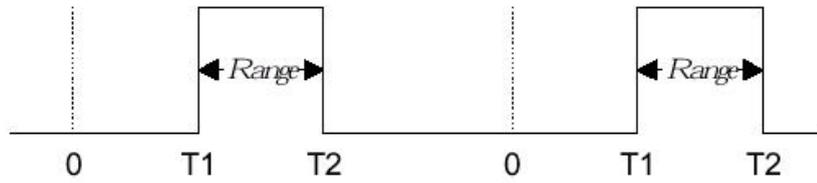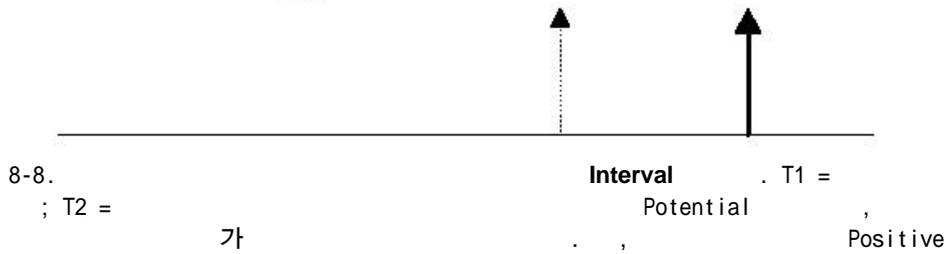
(   )   .   Qualified   . State Qualified

              . Edge Qualified
                        . Qualified
                    .   Potential
                    .

        .

                                            Edge   State Qualified
                      .

1.   Qualified   .

2.   Edge   State   Qualifier   .
     (Edge   ,
      Hold-off   .)

3.   .

4.   Qualifier   .

5.   Above
                                                              .

6.
                    ("within" T<)   .
                                        ("wait" T)
                              ("wait" Evs)
                    .   Qualifier
                    .
              2ns-20s   .
                        1-99999999
                    .

SMART TRIGGER
─type─
Glitch
Interval
Qualified
Dropout
Pattern
─by─
Edge State
(qualifier)
─trigger on─
1 2 3 4 Ext
Ext5
─only after─
1 2 3 4
Pattern
─goes & stays─
Above Below
0.996 V
─within─
130 ns
OFF T< T> Evs

QUALIFIED

State Qualified and Wait *(8-9) Time Events*
.

Time .
( ) .

.

Events .
.
.
. .

Trigger Source: Positive Slope

Qualifier: Pattern Present

Trigger can occur

Wait   *Wait*

Generated Trigger
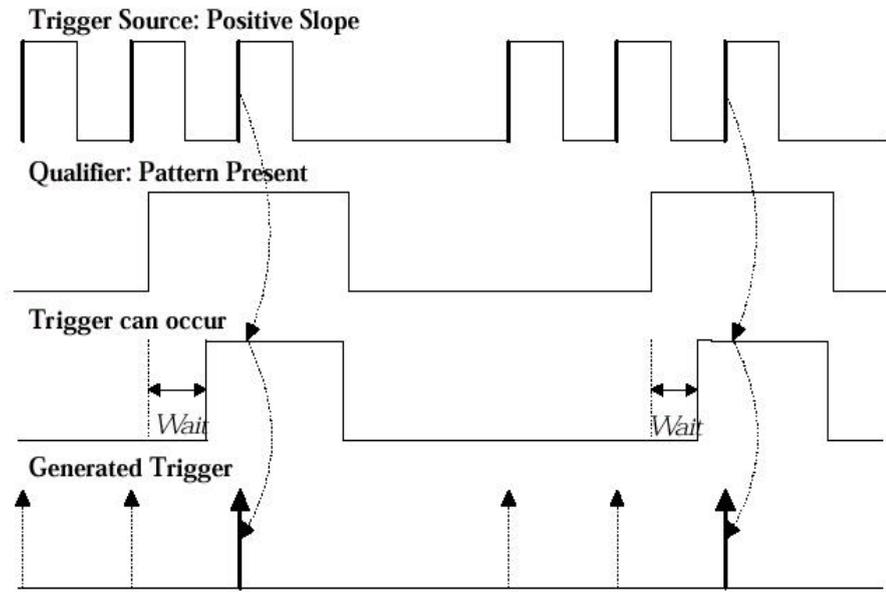
8–9. State Qualified and Wait: .
Potential , .

State Qualified and Wait *(8- 10)   Time   Events   .*

Time   *.   (   )*
                                            .

                        .

Events   *.*

                              .

                .   *.*

                              .   *.*

Trigger Source: Positive Slope

Qualifier: Pattern Present

Trigger
Threshold —
Setting

Trigger can occur

*Selected
Time*   *Selected
Time*

Generated Trigger
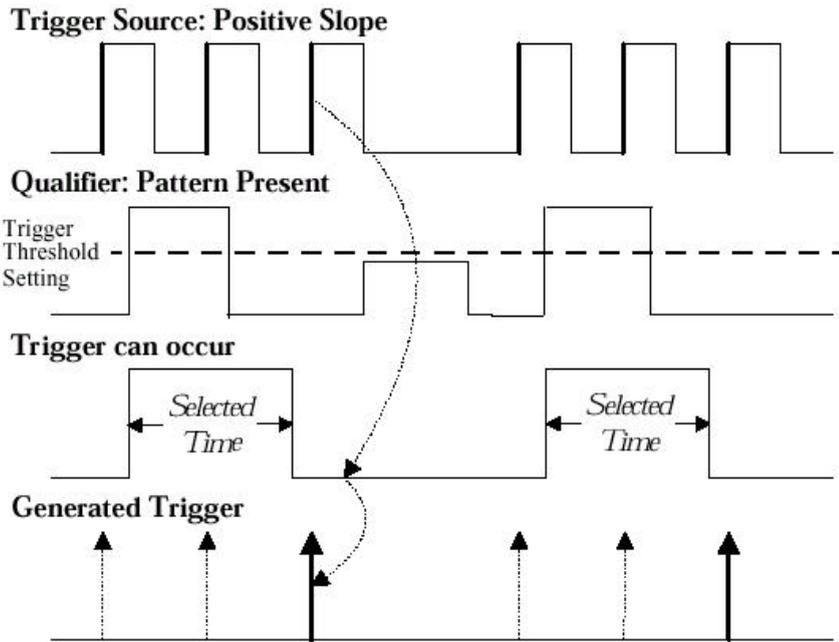
        8- 10. Edge Qualified and Wait: *.*
    Potential   **,**   *.*

LOST SIGNAIS

Dropout   "   "
                                                        (8-19   8-11).
            2ns   20s   .   Dropout
Pre-trigger   Single-shot   .

1.   1   .

Coupling

2.
                .

AUTO
SETUP

3.   .   "
        "   Dropout   .

SETUP

4.   TRIGGER   <<   >>   .

SETUP TRIGGER
(Glitch)

5.   .

Dropout   .

6.   Dropout   .

:   **Dropout**
                        (
).

                        . **WavePro DSO**

                        .

7.   .

8.   .

9.   (25ns)
           "   "   .

10.   "   "   .
            WavePro DSO   .

.

DROPOUT

Trigger Source

Trigger can occur

Wait Time-out

Wait Time-out

Generated Trigger
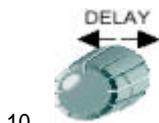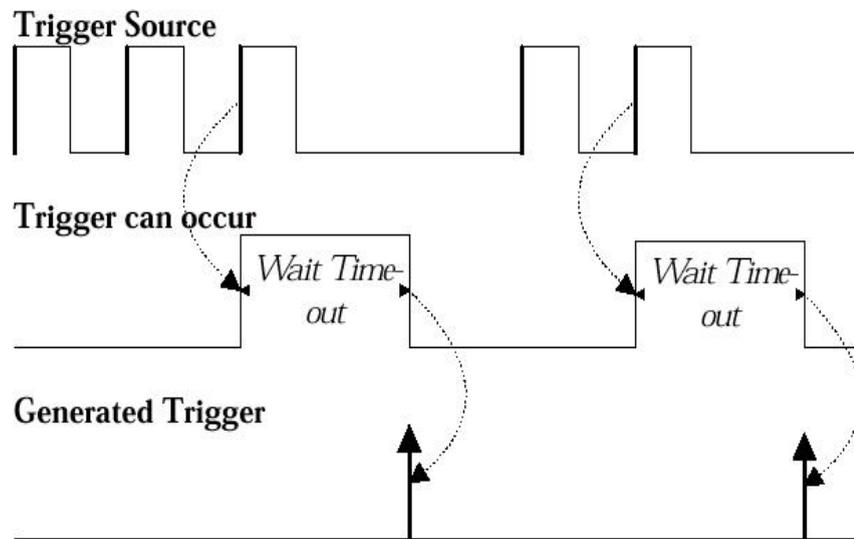
8 11. Dropout   :   .
.

Pattern

Pattern   CH 1, CH 2, CH 3, CH 4   EXT
                    .   AND   .
              ,   .   (   )
                        .   (X   don't care)   CH 1   CH 2
          EXT   .
                                                                  . 2ns ~ 20s   1
~ 99 999999   Hold-off   .

SMART TRIGGER

type
Qualified
Dropout
Pattern
Runt
Slew Rate

/   **Patter**n   .

trigger on
Exiting
Entering

Entering
                Exiting   .

Pattern with
1 2 3 4 Ext

                              .

coupling **1**
DC   AC
LFREJ HFREJ

                        . HF   .

level
- - -
L   H   **X**

                                    . , low, high, or
                        don' care.   .

holdoFF
- - -
OFF Time Evts

                                              (
). Hold-off

                                    .   Hold-off
                    2ns   20s   .   1 ~ 99
                    999 999   .
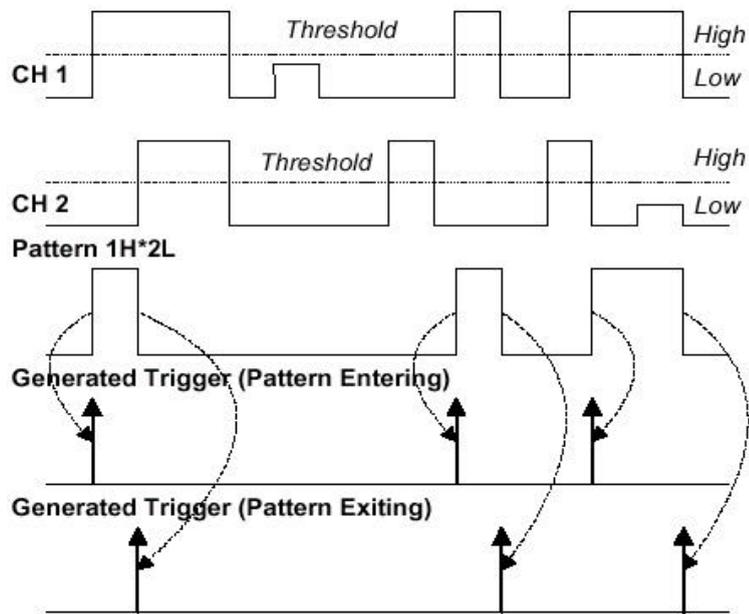
Pattern

8 12 Pattern

.

Pattern   :   .

.   .

Pattern

entering . *exiting*

.

. ,

10ns ~ 20s Hold-off 99.999.999 Hold-off .

Pattern AND

. deMorgan .

Bi-level Window Pattern Trigger . Bi-level

. Bi-level Pattern

. 1 2

. CH 1 +100 mV , CH 2 -200 mV

. CH 1 +100mV CH 2 –

200 mV Bi-level .

.

.

$$Trigger = CH\ 1 + \overline{CH\ 2}$$

, CH 1 = high OR CH 2 = low .

de Morgan .

$$Trigger = \overline{\overline{CH\ 1} ? \overline{CH\ 2}}$$

, CH 1 = low AND CH 2 = high .

.

Window Trigger .

.

Pattern . 1L*2H

1L*2H .

Runt

runt   ,
                                                              . 600ps   20s
                                             .
    (   )   runt   .
Runt   .

8 13 Runt Trigger

Trigger Source

Upper Threshold Level

Lower Threshold Level

Generated Trigger (Positive Slope)

Generated Trigger (Negative Slope)
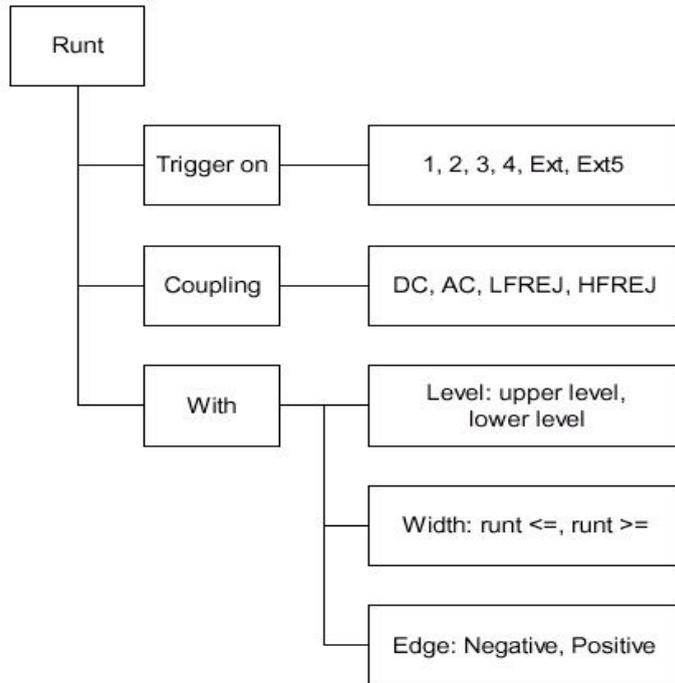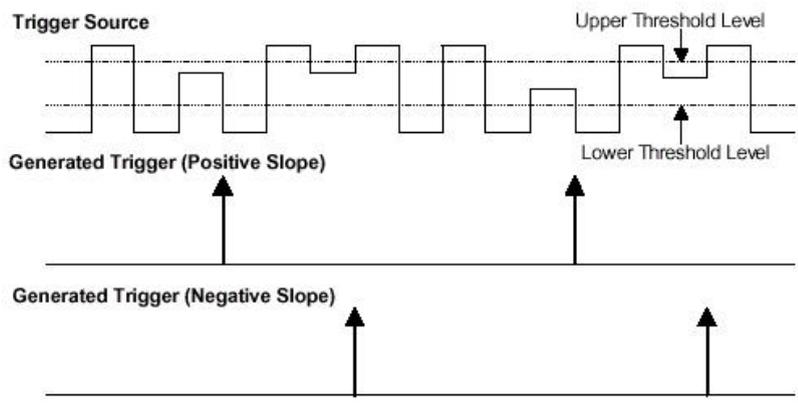
```
1  DC 0.408 V veto -128mV

               0.770 ms≤runt≤2.14 ms
```

8 14 Runt Trigger

(
).   Positive   ("Neg"   ),
                ("veto")   runt   .

(SlowRate)

(Slow Rate)

.   ,   .

. 600ps   20s

.

8 15 SlewRate Trigger

Trigger Source

dV

dT   dT   dT   dT

Upper
Threshold Level

Lower
Threshold Level
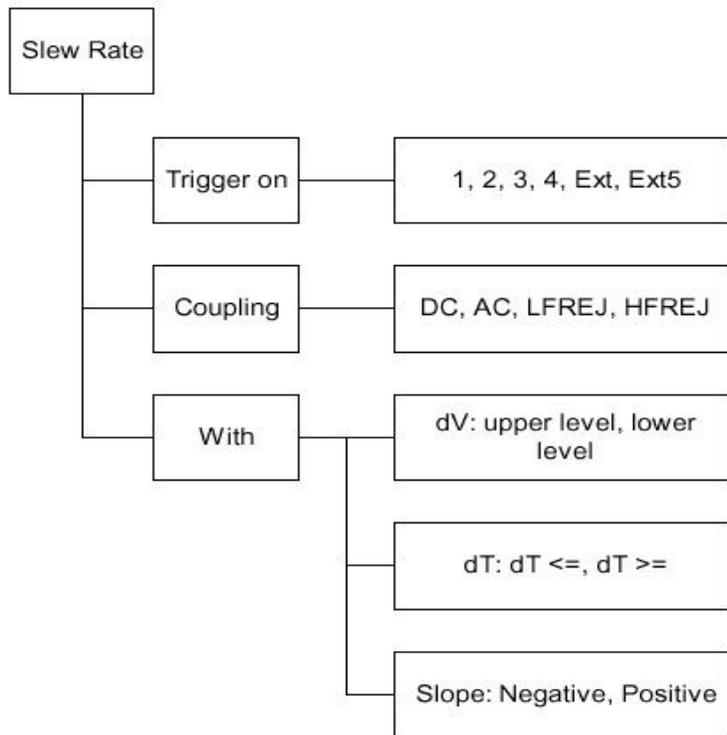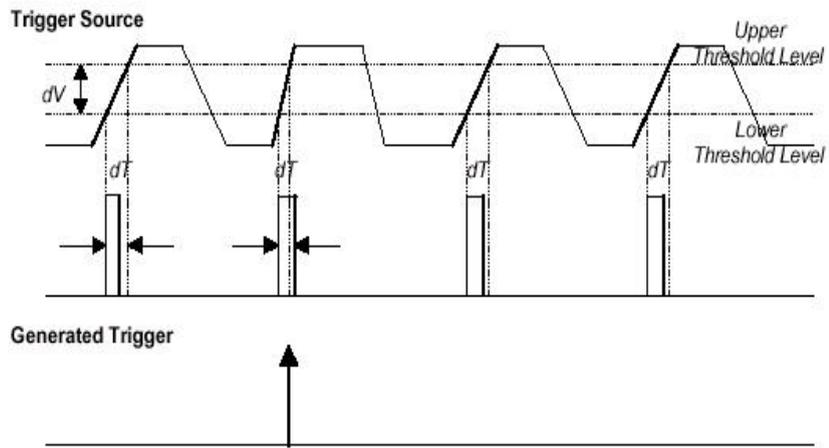
Generated Trigger

```
1  DC 0.556 V to   188mV
        slope >=    73.6 mV/ns
```

8 16   (dI)   ,
              (dV)   Slew Rate   .
Edge Trigger   (0.556 V)   (188 mV)   (e73.6
                     ns)   .

Qual First

Qualified First

       . Qualified First

      . Qualified First   Qualified Trigger   .

          .
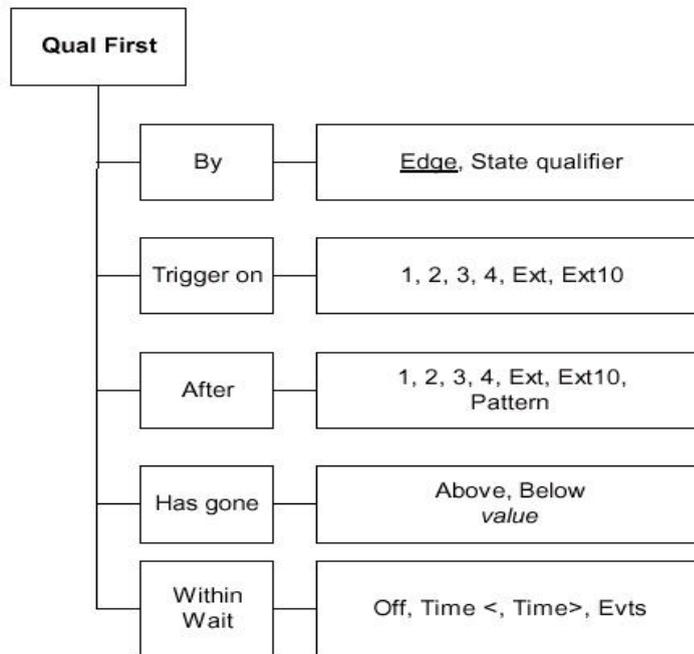
8 17. Qualified First Trigger
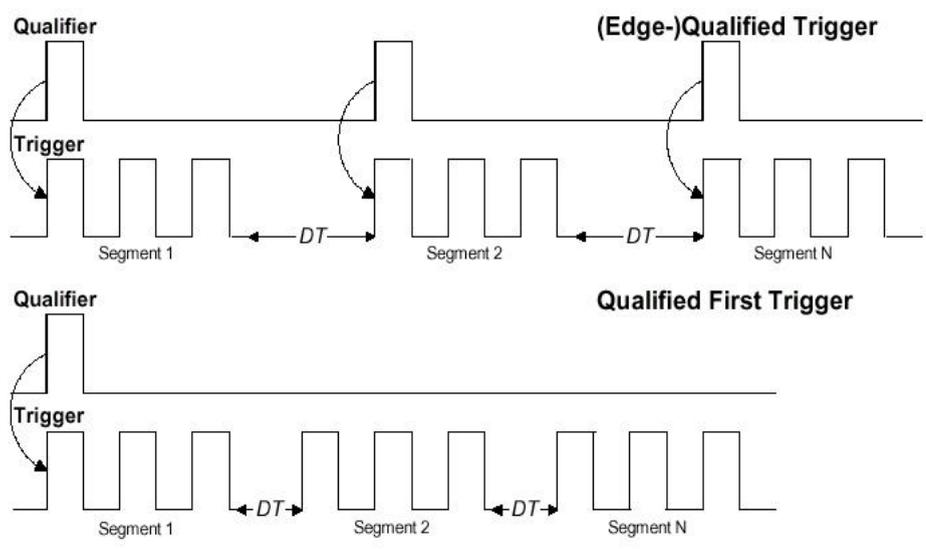
그림 8-18 Qualified ( ) 와 Qualified First ( ) 모드: (Edge-) Qualified
" "

Qualified First

. (DT) Sequence Mode Qualified First
. Qualified First .

§ § §

9 :

3 .

.

.

? Analog Persistence

?

?

? XY

? XY

ANALOG
PERSIST

.

WavePro DSO Analog Persistence
"   "   .

. Color Graded

.

WavePro DSO   .
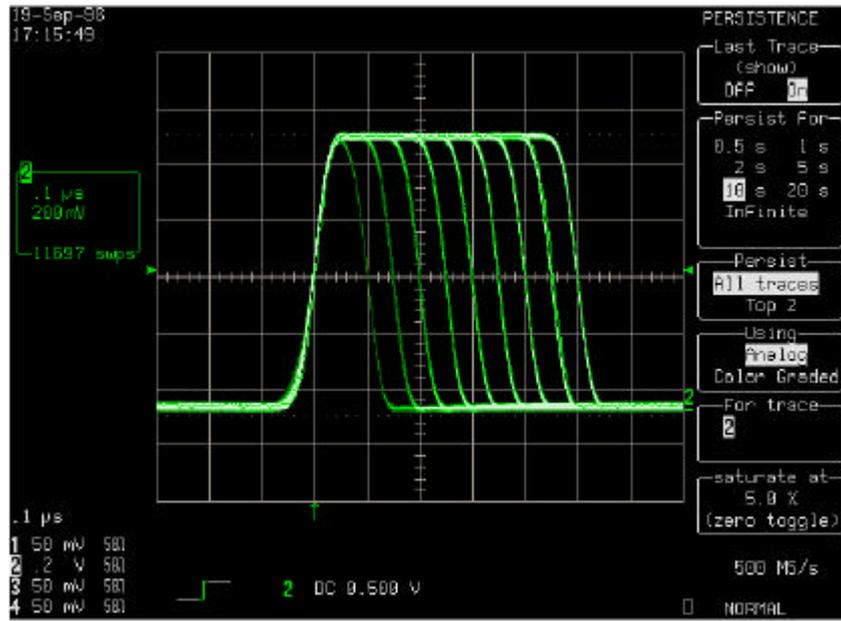
9 1.   **Analog Persistence**   .

ANALOG PERSISTENCE

LeCroy   Analog Persistence

.

.

,   .

.

.

.

.   .

DSO

.   *DSO*   .

Analog Persistence   .

.   .

3

.

.

.   *Integrity*

.   *Analog Persistence*   ,

.

Using persistence   "Analog"

.

.

,   , *0*

.

(   )

. *Analog Persistence*

.

.

.   ,   .

.

.

COLOR GRADED

Color-Graded　　　　　Analog Persistence

　　　. Using persistence　　　　Analog Persistence
　　　　　　　　　　　　　"Color Graded"　　　　WavePro DSO

　　　.

9 2 Color-Graded　　　　　　　　　　　　9 1

　　　　　　　　　　　　　　　　　　　　　　.

![wavepro logo]
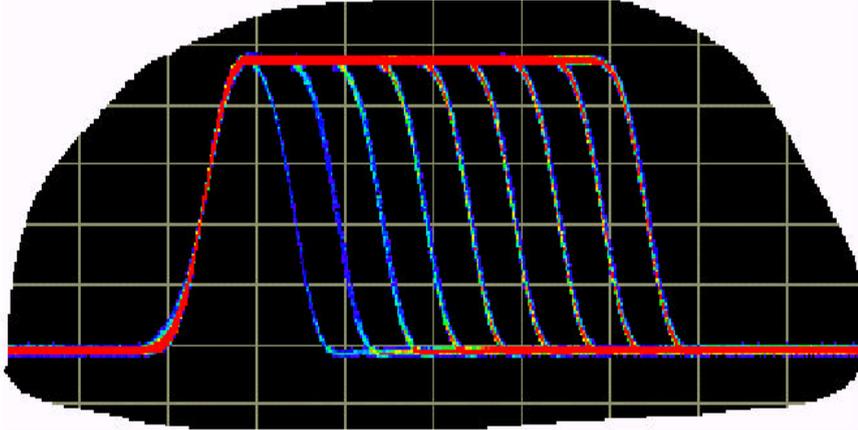
WavePro DSO

. DISPLAY   .

DISPLAY

1.   (3 "   "   )   "More Display Setup"
.

2.
.

MORE DISPLAY

Screen
Saver Setup   . "   "
.

Color Scheme   (1-6)   (U1–U4)
1 2 3 4 5 6   .
U1 U2 U3 U4   .   .
.   .

CHANGE COLORS   .
.

Full Screen   Full Screen
OFF On
.

Trace color   Opaque   Transparent
Opaque   .
Transparent   .

Measure Gate   Measure Gate   .
(highlight)   "neutral"
OFF On
.
Data Points   .
Normal
Bold   (   )   Normal   Bold
.

Full Screen   .
.

More Display Setup

1. .... U1, U2, U3 U4

CHANGE COLORS

.

CHANGE COLORS
in user color
scheme U1

Copy From
1 2 3 4 5 6
U1 U2 U3 U4

COPY SCHEME
1 to U1

Change
Trace 1
Trace 2
Trace 3
Trace 4
Trace A

color to
Cyan
Yellow
Green
Blue
Red

,   ,

.

(1-6)   (U1–U4)
.

.

Color Scheme

User   .

(   ).

"Change"

(9-7

).

W wavepro

 MORE DISPLAY   .
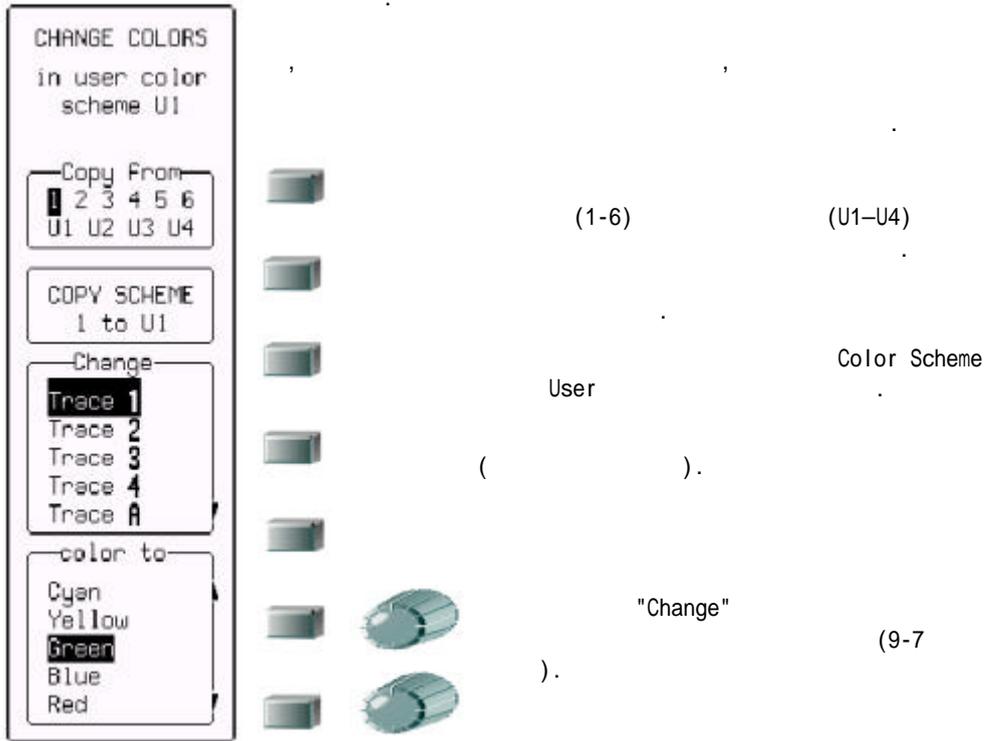
Background -

Trace 1...4 — Channel 1, 2, or 3   4

Trace A...D — Trace A, B, C   D

Grid —

Text —   ,

Cursors —

Warnings —

Neutral —   (   )

Overlays — Full Screen

color to
- White
- Cyan
- Yellow
- Green
- Blue

color to
- Red
- Light Gray
- Gray
- Slate Gray
- Dark Cyan

color to
- Cream
- Sand
- Amber
- Olive
- Light Green

color to
- Jade
- Lime Green
- Apple Green
- Emerald
- Grass Green

color to
- Ocean Spray
- Ice Blue
- Pastel Blue
- Pale Blue
- Sky Blue

color to
- Royal Blue
- Deep Blue
- Plum
- Purple
- Amethyst

color to
- Magenta
- Fuchsia
- Raspberry
- Neon Pink
- Pale Pink

color to
- Pink
- Vermilion
- Orange
- Cerise
- Khaki

:

. ,

,   ,
, *Neutral*   ,   ,
.

.

W' wave*pro*

XY

XY   Hertz   (Horizontal unit)
                (time/div)   . XY
                              .   ,   XY only, XY Single
XY Dual   .

DISPLAY

1.   DISPLAY SETUP   .

2.   XY   .

DISPLAY SETUP

3.   XY
                                              .

Standard
XY

"Standard"   XY   .   ANALOG
                                                 PERSIST
Persistence
OFF   On   .   .

XY   Analog   Color-
Setup   Graded   XY
                                                                .

More Display
Setup   . 9-4
                                        .

Grids
XY only   .
Single Dual   .

W'Form+Text
intensity   .
90 %
                                                                         .

Grid
intensity   .
75 %
                                        .
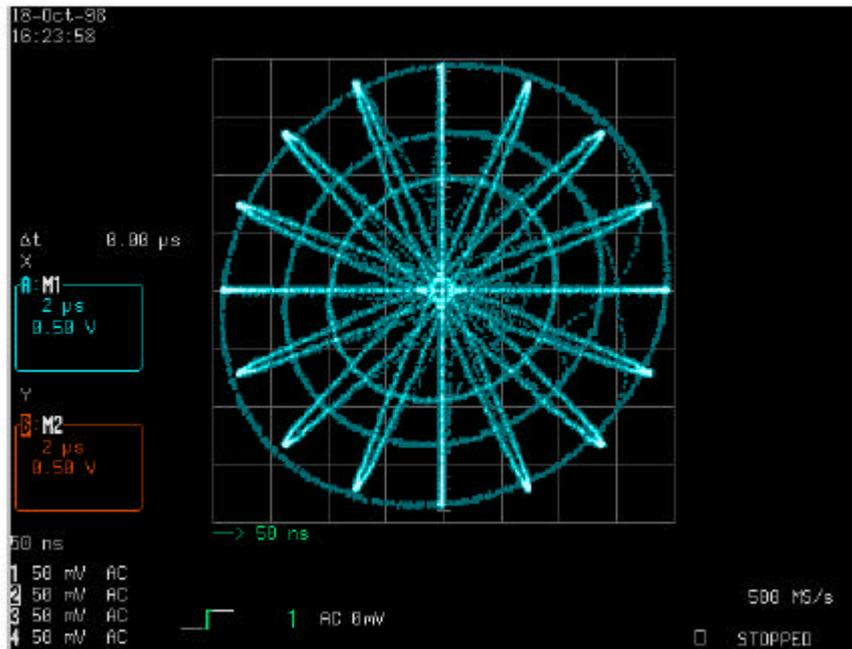
9 3 XY Only   Analog Persistence   .   : XY Only, Single
Dual   .
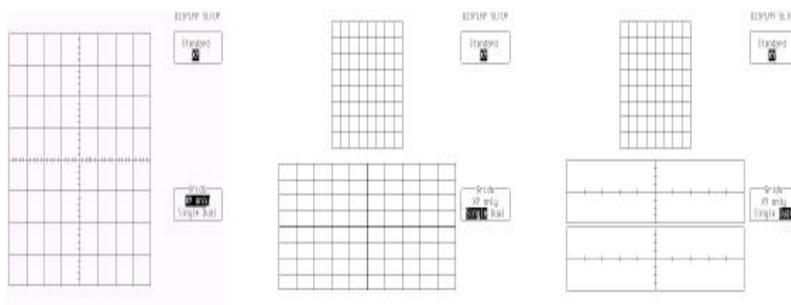
XY

XY (*4*
" ").

Absolute Amplitude
. *XY Relative Amplitude*
.

Absolute and Relative Time *Standard* *XY* .
.

? Y value / X value":

"20 ∗ log 10 (ratio)": **dB**

?DY value ∗ X value":

"*f = arc tan* (Y / X) range [−180?to +180°]": **( )**

"*r = sqrt* (X ∗ X + Y ∗ Y)": **( )**

X   Y   *.*

      X   Y   *.*

	A Abs	A Rel	T Abs		T Rel
			Org = (0,0)	Org = V Xoffset V Yoffset	
X	V XRef − 0	V XDif − V Xref	V XRef − 0	V XRef − V Xoffset	V XDif − V XRef
Y	V YRef − 0	V YDif − V Yref	V YRef − 0	V YRef − V Yoffset	V YDif − V YRef

.

A Abs : *Absolute Amplitude*

A Rel : *Relative Amplitude*

T Abs : *Absolute Time*

T Rel : *Relative Time*

Org *Origin*

V Xref : *X trace   Reference*

V Yref : *Y   Reference*

V Xdif : *X trace   Difference*

V Ydif : *Y trace   Difference*

§ § §

10 : **Math**

WavePro DSO Math .

Math .

.

? **Extrema**

? **Resolution**

?

? **FFT**

? **Math**

?

Math

Extrema

Extrema   Envelope   . WavePro DSO
                                    (   )   (   )   Extrema
                    .

                                .   WavePro DSO
Envelope   .

(image: button "1")

1.   1   WavePro DSO   .

(image: button "A")

2.   Trace A   .

SETUP

3.   .

—use Math?—
No **Yes**

4.   SETUP OF A   .

5.   "Math Type"   "Extrema"   .

—limits—
Env
Floor Roof

                                                                          :

6.   .   ***Envelope***
                                                                              .

Envelope   Envelope   **Floor**   **Roof**   Envelope
                    .   .

—for—
1000
(sweeps)

7.   .

—of—
1 2 3 4 B C D
M1 M2 M3 M4

8.   .
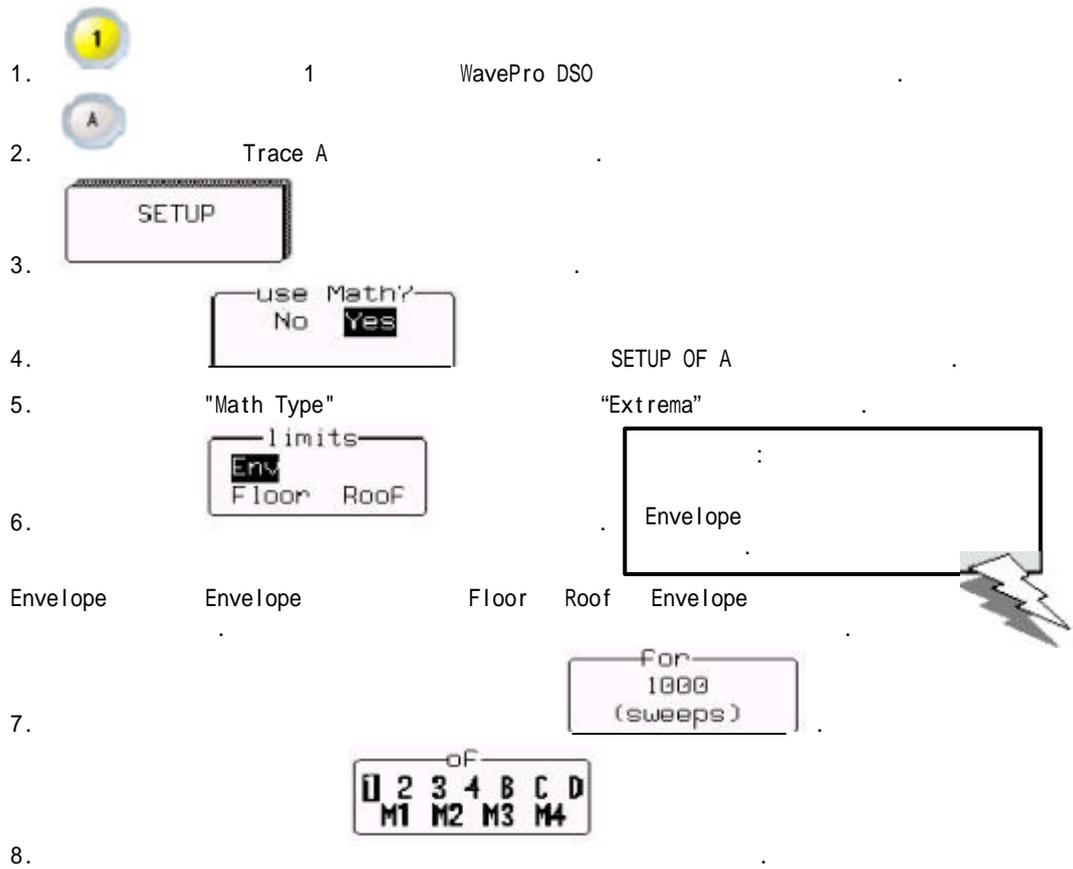
wavepro

Extrema

WavePro DSO

. NORMAL STOP (STOP
)   .

.

CLEAR SWEEPS   ,   ,   ,
Extrema   . *WavePro*
DSO Extrema
.

.

the SETUP "for"
.   .
.

: *WavePro DSO*		*Math*
	.	
		.
		.
WavePro DSO *n*		.
n		.
		.
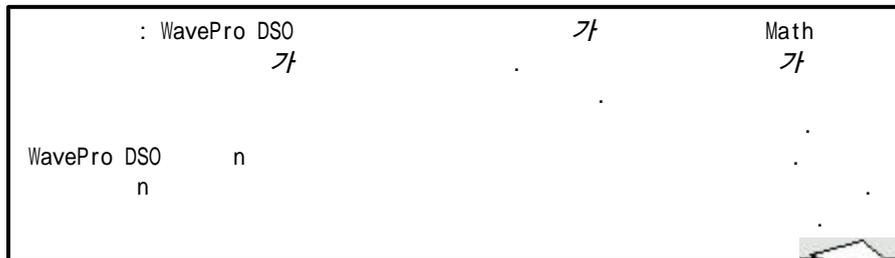
Math   (a)   (b)
.   .

1.   A, B, C   D   Math   .

2.   Math Type   Rescale   .

3.   Math Type   a   b   .

4.   ,   .   .

5.   [units]   . ""   ,   ,
     , Hertz,   ,   ,   ,
                                                  .

6.   .

Summed Averaging
              .
                                                                          .
                                                                          .

                                                  .
              .   .   NORMAL
STOP   . *WavePro*
DSO   . *CLEAR SWEEPS*
     ,   ,   ,
                                      .
                                      .
                          (   ).

Continuous Averaging
        .
        .
     . ,
     .   "   "
              (   ).

ERES (Enhanced Resolution)

. WavePro DSO ERES

.   .

ERES   ERES   (
).

.   .

.

1.   A, B, C   D   Math   .

```
┌─Math Type──┐
│ Average    │
│ Correlate  │
│ Enh.Res    │
│ Extrema    │
│ FFT        │
└────────────┘
```

2.   Math Type   Enh. Res   .

```
┌─enhance by─┐
│  0.5 bit   │
│   1 bit    │
│  1.5 bits  │
│   2 bits   │
│  2.5 bits  │
└────────────┘
```

3.   1.5   .

0.5   0.5   3.0
.

```
┌──────of──────┐
│ 1 2 3 4 B C D│
│ M1 M2 M3 M4  │
└──────────────┘
```

4.   .

:   .   ┌─────────────────────────────────┐
                                                │ :   *WavePro DSO*   │
                                                │   │
                                                │   .   │
                                                │   *Averaging:* │
                                                │   .   │
                                                └─────────────────────────────────┘

```
5-Nov-98                                                    SETUP OF B
9:57:53
1                                                          use Math?
  50 ns                                                     No  Yes
  0.50 V
                                                           Math Type
                                                           Arithmetic
                                                           Average
                                                           Enh.Res
                                                           Extrema
                                                           FFT

B:Eres(1)
  50 ns
  0.50 V
                                                           enhance by
                                                           0.5 bit
                                                           1 bit
                                                           1.5 bits
                                                           2 bits
                                                           2.5 bits

                                                           1 2 A C D
                                                           M1 M2 M3 M4

50 ns
1 .5 V DC                                                   500 MS/s
2 20 mV DC
          B:Eres(1)
          + 1.5 bits              250 -> 242 pts
          -3 dB bw=0.121*Nyquist=30 MHz           □   STOPPED
```
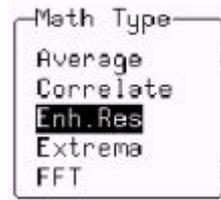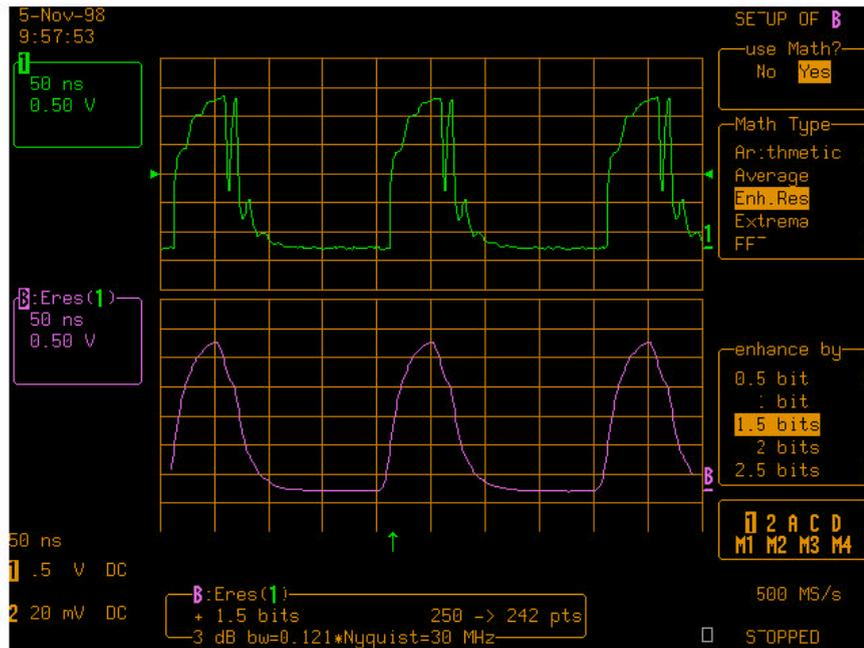
10 1.   **ERES**   .
                                            . **Trace B**

          .   **Trace B   Channel 1   ERES**
             1. 5   **250   242**   **(10**
             7   )   **30 MHz**   .

WavePro DSO

WavePro DSO
                       .
                                             .   *(SNR)*
                .
                                                        .

WavePro DSO   *FIR(Finite Impulse Response)*   *0.5*
                    0.5   3

.

.   .   .

	|-3 dB (x Nyquist)	( )
0.5	0.5	2
1.0	0.241	5
1.5	0.121	10
2.0	0.058	24
2.5	0.029	51
3.0	0.016	117

SNR

.

SNR

White

Noise

.

SNR

.

.

,   ***

.

.   *0*   .

.   ,

.   ,   (

)   .

.

.

,

.

.   .

WavePro DSO

.

: ( ) ( ) .

.

(" ")

3
.

:
.
( ) *2*
. ( ) " "
,
.
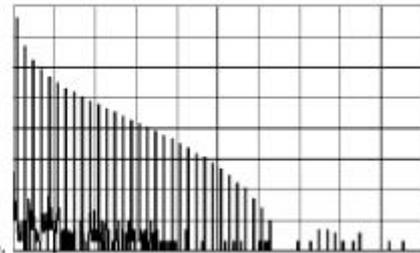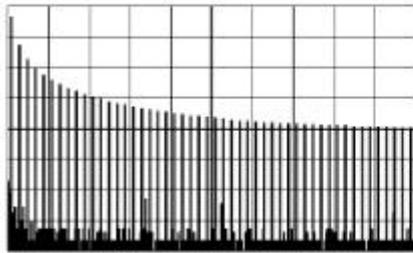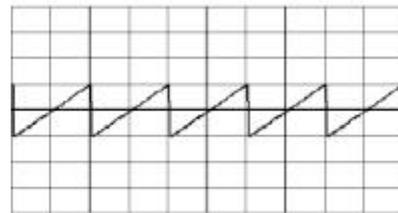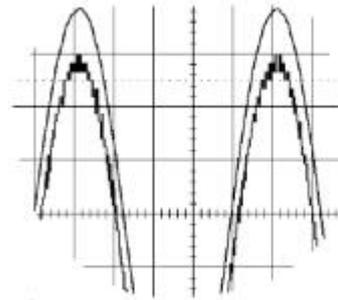
:
.
.
.
.
.
.
. , *2* 117 . (50 000
0 2%) .
.
WavePro DSO ERES .

FFT

1 (5 "Math ") Fast Fourier Transform(FFT)
. FFT Average
FFT Time Span .
.

FFT Average

1. A, B, C D Math .

2. Math Type FFT AVG .

3. FFT . Power Spect
FFT FFT .

CLEAR
SWEEPS

4. FFT Math
.

FFT FFT Averaging

.

```
C:PS(AVGP(B))
Power Spectrum    10000 -> 2500 pts
```

PROCESSING

FFT
Math
.
,
-

.

: *FFT*	*(Time Span),*
Nyquist	
	. FFT
-	.

FFT

.
-
.
-

.

.

.

: ***FFT*** .
- *"Incompatible input record type" – FFT Average* ***FFT***
.
- *"Horizontal units don't match" –* - ***FFT*** .
- *"FFT source data zero filled" –*
( ) ***FFT*** *0* .
- *"FFT source data over/underflow" –* (
) . ***FFT***
. *Acquisition*
.
/ .
- *"Circular computation" –* *Circular* (,).

FFT *(Time Span)*

FFT   *f*   .
                                .
                FFT   *f*   .

Acquisition   *(Channel 1, 2, 3*   *4)*
     .   *TIME/DIV*   *10*   .
                    .
                  (*10-2).*
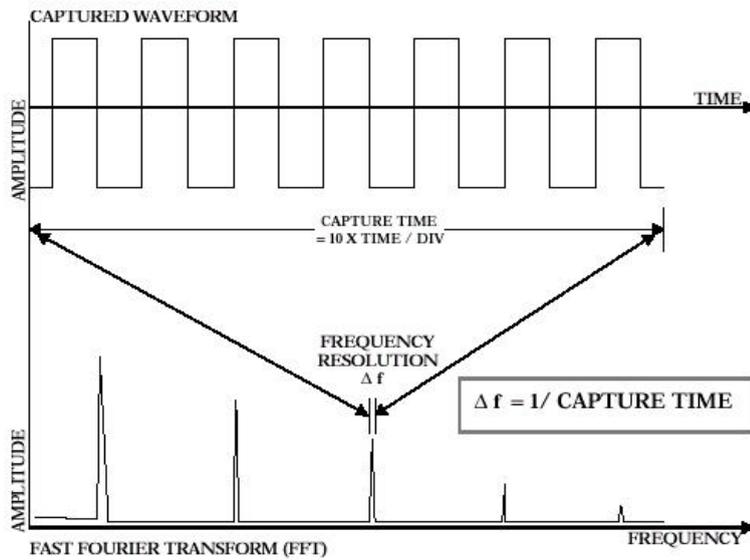
                 10-2.   **D**   .

FFT   *(Time Span)*   *Nyquist*
            . *Math*   *Time Span*
              .   *"Math*   *"*   *FFT Time Span*
      FFT   *(Time Span)*   . *FFT Time Span*
     (1/ T)   *(10-3).*

CAPTURED WAVEFORM

AMPLITUDE

TIME

ΔT
SAMPLING PERIOD

FREQUENCY SPAN

FREQUENCY SPAN = K* (1/ΔT)

AMPLITUDE

FAST FOURIER TRANSFORM (FFT)

FREQUENCY
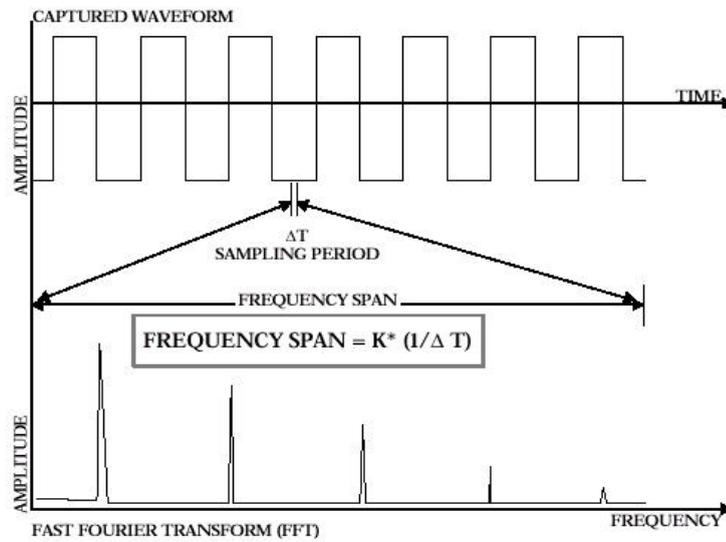
10 3 FFT Time Span (1/DT).

*WavePro DSO (Time Span) FFT
"Math " .
. FFT
Time Span Hz/div . (Time
Span) FFT Nyquist .*

FFT Time Span

1.   FFT (Time Span) Time Span
. Acquition
. .
10 MHz Time Span 10 kHz
. 100 ms . 10
ms 10 kHz Df .
10 MHz (Time Span) 20 MS/s
. 500 MS/s 50000 WavePro DSO
10 ms time/div 250 MHz (Time
Span) .

TIME / DIV

s   ns

2.   10 ns

.   10 MHz   (Time
Span)

.

SETUP
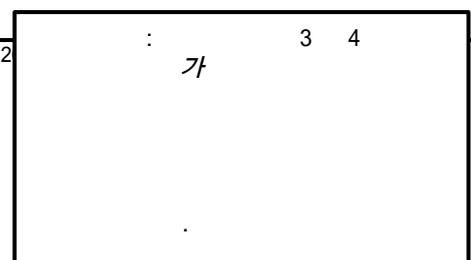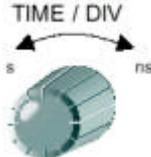
3.   "record up to"   25MS/s   2500
.

For Math use
max points
1000

4.   2500   .

500 MS/s   FFT
25 MS/s   .   (Time Span)   >10MHz
(Time Span)   12.5 MHz   .

25 MS/s   12.5 MHz(1.25 MHz)   . 1, 2
5   WavePro DSO
2000   FFT   .   2MHz/Div
.   6.25   12.5 MHz   (Time
Span)   .

FFT				
	(dB)	(dB)	ENBW( )	(dB)
	−13	3.92	1.0	0.0
von Hann	−32	1.42	1.5	−6.02
Hamming	−43	1.78	1.37	−5.35
	−44	0.01	2.96	−11.05
Blackman-Harris	−67	1.13	1.71	−7.53

Math

. Math
5 "Math " .

1. A, B, C D Math
.

2. Math
.

```
┌─────────────────────┐
│  : WavePro DSO      │
│                     │
│        .            │
│                     │
│                     │
│        .        � │
└─────────────────────┘
```
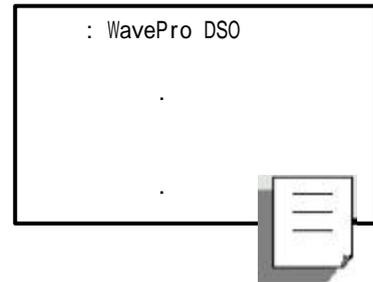
```
┌─────────────────────┐
│ SETUP OF A          │
│ ─use Math?─         │
│   No  Yes           │
│                     │
│ ─Math Type─         │
│  FFTAVG             │
│  Filter             │
│  Functions          │
│  Jitter             │
│  Histogram          │
│ ─Function─          │
│  Exp10              │
│  Identity           │
│  Integral           │
│  Log                │
│  Log10              │
│ ─oF─                │
│  +1.17000 E-03      │
│  6 digits           │
│ ─plus─              │
│  1 2 3 4 B C D      │
│  M1 M2 M3 M4        │
└─────────────────────┘
```

Math .

Functions .

```
┌──────────────────────────────┐
│           :                  │
│     - 10 -15      +10 15      │
│                              │
│                         .    │
└──────────────────────────────┘
```

Integral
.

DC
.

.

![wavepro logo]

' .

.

1. .

2. . **Setup** .

3. .
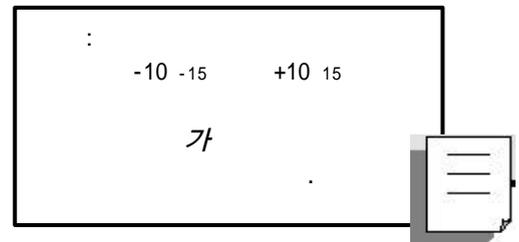
SETUP OF A

use Math?
No Yes

Math Type
Per.Hist
Per.Trace
Resample
Rescale
SeqPack

Math .

Resample .

Delay By
0.00 ns

±2000ns   Trace A

.

.

1 2 3 4 B C D
M1 M2 M3 M4

.

.

WavePro DSO

.

.   100
            20000   .
            X-Y
.

1.   .   11   "   "
                  .   "

2.   A, B, C   D   Math   .

3.

SETUP OF A

use Math?
No Yes   Math   .

Math Type
Per.Trace
Resample
Rescale
SeqPack
Trend   .

MORE
TREND SETUP   (
).

                                                              .

FIND CENTER
AND HEIGHT   .

Trend of
custom line 1
ampl(1)   .

using up to
1000   (
(values)   ).   20000
                                                      .

                                                                            .

TREND **A**

Values
All Average
All/Trace

PARAMETER
SETUP

FIND CENTER
AND HEIGHT

Center
+0.00000 E+00
6 digits

Height
1.000
(per div)

:

*LeCroy Application
Briefs (LABs)* . *WavePro*
LeCroy
LAB .
http://www.lecroy.com/Labs/default.asp
.

ALL .
. **Average**
.

CHANGE PARAM
. 11 " " .
.

.

.

.
(8)
"Center"
.

.

(***)
Math   .

```
⌐■:Tampl(1)─┐          ?
│ 20 #       │          ?              ,
│ 200μV      │          ?
│   49.731mV │
└─inside 200┘          ?
```

```
⌐■:Tampl(1)─┐
│ 20 #       │
│ 200μV      │          ?
│⇓1%/⇑0%     │
└─inside 193┘
```



```
        ↑
   TIME │
        │
        │
        │
        │
        └──────────────────→ EVENTS
```

10 4   ,
.   .

wavepro

.

.

.
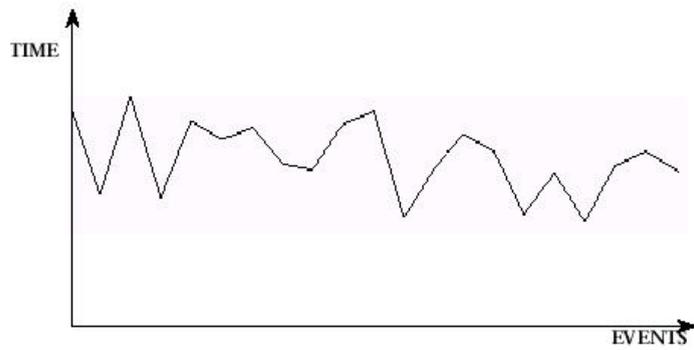
XY   *x*   *y*

.

.

A

B   *Acquisition*

C

D

E

.

.

.

(

).

WavePro DSO   *20000*

.   '*N*

20000   /*N*   .

20000   '*N*   .

'*N*   *20000*   .

.

.

.

FIND CENTER AND HEIGHT   .

.   *WavePro DSO*   ,

.

.

Acquisition   *Acquisition*
.   .
Acquisition   .

Acquisition   .
.

§ § §

11 :

1 **WavePro DSO** .

.

.

?

? Pass/Fail

?

?

MEASURE

1. MEASURE   .   1   4   "   "
        .

2.   **Parameters**   "mode"   **Custom**   .
                                        "from and to"
                    .
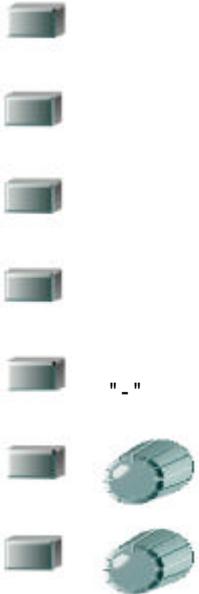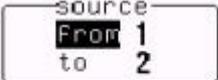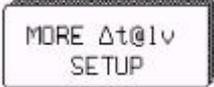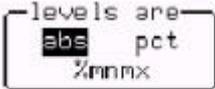
CHANGE
PARAMETERS

3.   CHANGE PARAM
        .

                                4.   .

CHANGE PARAM
─On line─
1 2 3 4 5

─Category─
All
DISK-Std
DISK-Local
DISK-PRML
JTA

DELETE ALL
PARAMETERS

─measure─
 --
acsn
ampl
area
avg

─of─
1 2 3 4
A B C D

"_"

![wavepro logo]

.

1.

.

2.   "category"   **All**   Δt@lv
          .

source
From 1
to   2

3.   from to
          .

MORE Δt@lv
SETUP

4.   .

     SETUP of   t@lv   .

5.   .

levels are
abs pct
%mnmx

hysteresis
0.5 **1** 2 5
divisions

6.   Hysteresis   .
                                                                 .

                                    Hysteresis
                             .

from
0.00mV
Pos Neg First

7.   .
          WavePro DSO   .

8.   Positive(   )   Negative(   )   .   First

to
0.00mV
Pos Neg First

9.
          .   .
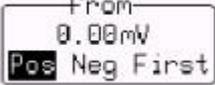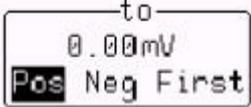
10.   Positive( )   Negative( )   .
   First   .

Pass   Fail

                      Pass/Fail   .

                                . WavePro DSO

               Pass   Fail   .

                          .

         .   Pass   Fail   .

?
?
?   , *PC Card*

?
?   *BNC*

                          , *Pass*   ,
           .

Pass   Fail

1.   4   MEASURE   .

2.   **Pass**   **Fail**   .
         "from and to"   .


```
CHANGE TEST
CONDITIONS
```
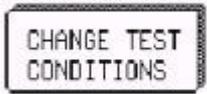
3.   .

        CHANGE TEST

4.   .

5.   "Test on"   **Param**
         .   "-"   .

6.   "choose"   **Param**   .

7.   11-1   .

![wavepro logo]

8.   Pass/Fail   "choose"
       Limit   .

-True if-
  <   ▶

9.   ,   .

-limit-
+0.00 E+00
3 digits

10.
                 .

       ,   .

11.   ?   ?   ?   .

12.   ,
       .
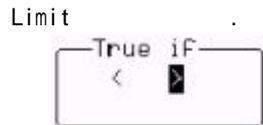
Pass/Fail

1.   CHANGE TEST   1   5   .

-Test on-
Param Mask
PolyMask --

2.   Mask
       .   "-"   .

-True iF-
all points
some points

3.   .

-are-
inside
outside

4.   .

5.   "of"
                                          .

┌───┐
│   :   Pass/Fail   │
│   .   .   │
│   .   │
│   ,   │
│   .   │
└───┘
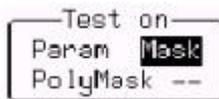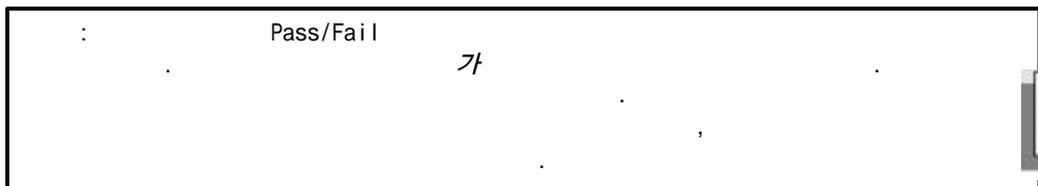
MODIFY MASK

1. CHANGE TEST

2. **W'form** , PC **Card**

Card ,
Floppy

D=M4

M1, M2, M3 M4 . "RECALL

W'FORM

. WavePro DSO

MODIFY MASK
From
W'Form HDD
Card Flpy
into
D=M4
M1 M2 M3 M4
INVERT MASK
D=M4
Use W'Form
1 2 3 4 A B C
D M1 M2 M3 M4
MAKE MASK
D=M4
delta V
0.50 div
delta T
0.20 div

On line
1 2 3 4 5
Action

1. CHANGE TEST

2. Pass Fail

IF
Pass Fail

3. "Then"
(Yes) (No)
. **yes** **no** "Then"

WavePro DSO

. WavePro DSO

.

(11-1).

. (centroids)

. centroid

centroid . WavePro DSO

. (ampl)

90% 10% . (WaveAnalyzer .)

図 11-1

(r@level, f@level)

.

.

(=0%
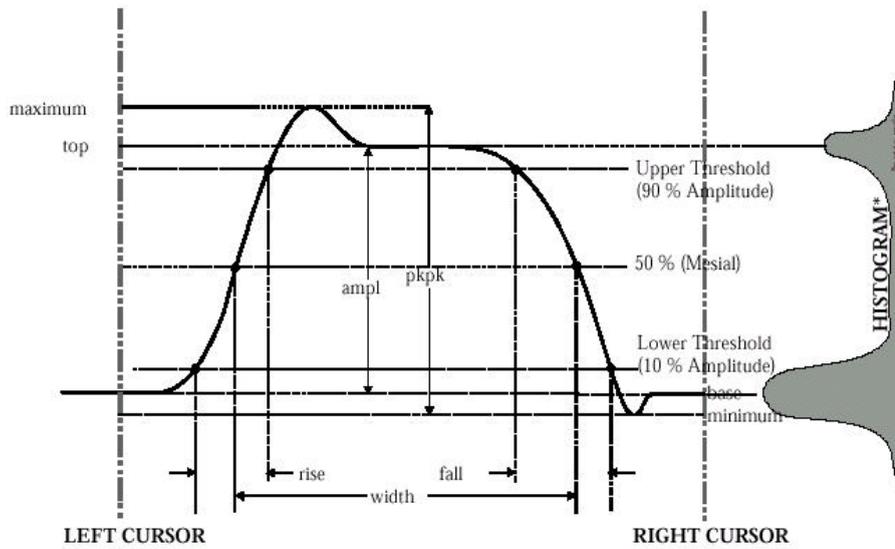
=100%) .

Rising Edge Duration	$\dfrac{1}{Ml} \displaystyle\sum_{i=1}^{Ml} \left(Tl_i^{\,90} - Tl_i^{\,10} \right)$
Falling Edge Duration	$\dfrac{1}{Mt} \displaystyle\sum_{i=1}^{Mt} \left(Tt_i^{\,10} - Tt_i^{\,90} \right)$

Ml	
, Mt	,
i	$x\%$
i	$x\%$

(50%) *mesial*
(11-2)
.
.
rms
.

first — delay — last

width — width — width

50 %
(Mesial)

PERIOD — PERIOD

freq = 1/period   duty = width/period

TWO FULL PERIODS: cycles = 2

cmean, cmedian, crms, csdev
computed on integral periods

TRIGGER
POINT

area, points, data
computed between cursors

LEFT CURSOR   RIGHT CURSOR
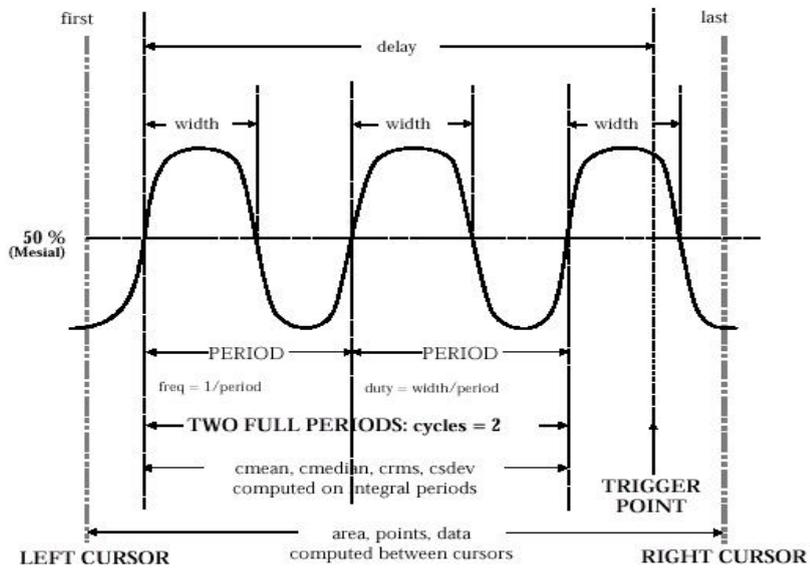
crms *cmean* . *WavePro DSO*

'

(11-3). *c2d±*

.

Noisy spikes ignored due
to Hysteresis band

HYSTERESIS
Band
DATA (1)

THRESHOLD

CLK (2)

Δc2d-(1, 2)

Δc2d+(1, 2)

LEFT CURSOR

TRIGGER POINT

RIGHT CURSOR

CLOCK EDGE = Positive Transition
DATA EDGE = Negative Transition

11-3
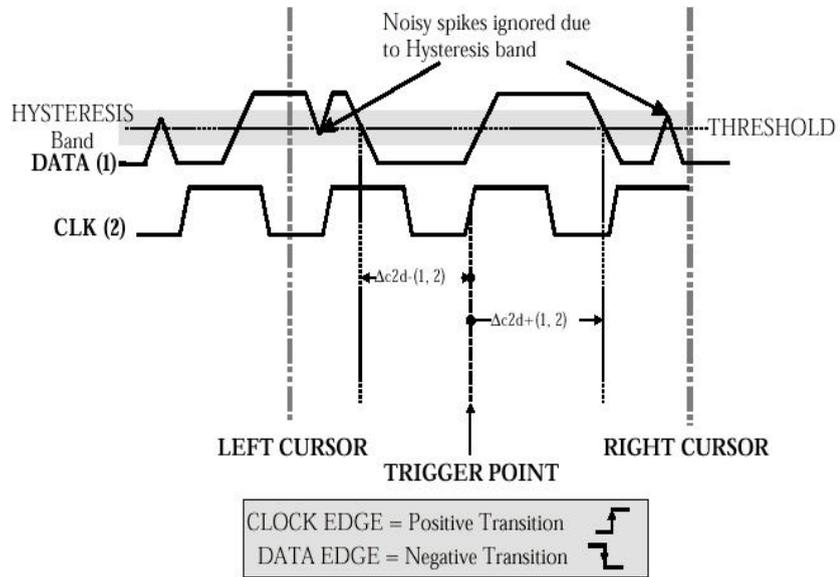
Hysteresis *Hysteresis*

. 11-3 *c2d-(1, 2)* ( )

Negative .

c2d+?(1, 2) .

WavePro DSO

WaveAnalyzer (5 " ").
.

Ampl	: . , Overshoot, Undershoot ringing pkpk .	- (11-6 11-1)	( ) pkpk .
Area	: . . .	(11-7 11-2)	
Base	(top). . , Overshoot, Undershoot ringing min .	(11-6 11-1)	( ) min .
Cycles	. . Positive Negative .	(11-7 11-2)	
Cmean	: . mean .		

Gradian	: . mean .	50% 50%	
crms	: . rms .	$$\sqrt{\frac{1}{N}\sum_{i=1}^{N}(v_i)^2}$$	, v_i , N *100* .
Gsdev	: . sdev .	$$\sqrt{\frac{1}{N}\sum_{i=1}^{N}(v_i - mean)^2}$$	, v_i , N *100* .
Delay	: 50% . .	50% (11-7 11-2)	
dly	Ddelay: 50% .		
t@lv	t: . .		. *Hysteresis* .

c2d±	Clock to data ± : (c2d+) (c2d-) .		(11-8 11-3)	. *Hysteresis* *Hysteresis* .
Dur	dur 0 , , .		:	
Duty	:		/ (11-7 11-2)	
f80 20%	Fall 80-20% , 80% 20% .		80-20%	( ) .

f@level	: .	.	( ) .
Fall	: . . .	(11-6 11-1) .	( ) .

		1%	45%	10%
		55%	99%	90%

. :

= × amp/100+ base

= × amp/100+ base

first	.	(11- 7 11- 2)	. . .
Freq	: 50% . . .	1/ (11- 7 11- 2)	
Last	( ) .	(11- 7 11- 2)	. . .

Maximum	. .	(11-6 11-1)	. . . maxp .
Mean	. centroid .	(11-7 11-2)	. .
Median	.	(11-7 11-2)	
Minimum	. .	(11-6 11-1)	. .

Over-	Negative Overshoot:
	
	                    Overshoot
	    .
		$$\frac{	base - minimum	}{ampl} \times 100$$
				
				(11-2)
					.
					                                    (
					
					                                 )
					
					                                      .

Over+	Positive Overshoot:
	
	Overshoot .
		$$\frac{	maximum - top	}{ampl} \times 100$$
				
				(11-1)
					.
					                                    (
					
					                                 )
					
					                                      .

Period	50%
	
	                                .
	
	                            .
	
	                        .
		$$\frac{1}{MI} \sum_{i=1}^{MI} \left(TI_i^{90} - TI_i^{10} \right)$$
		
		(11-7
		        11-2)
			, MI
			    , MI
			            ,
			i $x\%$
			                    i $x\%$
			                .

pkpk	:
	            . ampl
	
	                .
		(11-
		6
		11-1)
			.
			
			                                      .

Phase	.		
Points	.	(11-7 11-2)	
r20 80%	20% 80% : 20% 80% , .	20-80%	( ) .
r@ level	: .	.	( ) .
Rise	: (10-90%). . |	1%	45%	10%	 |		55%	99%	90%		(11-6 11-1).	( ) .

	. : = ?amp/100+ base = ?amp/100+ base		
Rms	- sdev .	$$\sqrt{\frac{1}{N} \sum_{i=1}^{N}(v_i)^2}$$ (11-7 11-2)	. . , v_i , N 100 .
Sdev 	- rms .	$$\sqrt{\frac{1}{N} \sum_{i=1}^{N}(v_i - mean)^2}$$ (11-7 11-2)	. . , v_i , N 100 .
t@level 	: (t=0) .	:	

top		(11- 6 11- 1)	.
	,		
	.		.
Width	50% .	*fwhm*	
	Positive	Positive Negative (11- 6	.
	.	11- 1 11- 7 11- 2).	
	Negative		
	.		
	.		
XAtX	.	.	.

XXXX	.	.	.

§ § §

wavepro

BLANK PAGE

12 : WavePro DSO PC

WavePro DSO

·

· WavePro DSO

· ASCII

· WavePro DSO Spreadsheet, Mathcad MATLAB

WavePro DSO 与 PC

PC

WavePro DSO   GPIB, RS-232-C   LAN (   )
          (PC)   .   LeCroy   ScopeExplorer   (
)   PC   .
WavePro DSO   Remote Control Assistant
          (12-3   ).   PC
          .

UTILITY

1.   Remote Setup   .

REMOTE SETUP
─Control From─
GPIB RS232
Network

─RS232 Mode─
7-bit
8-bit

─Parity─
none
odd even

─Stop bits─
1 2

─Baud Rate─
300   1200
2400   4800
9.6K   19.2K
57.6K 115.2K

Network
Setup
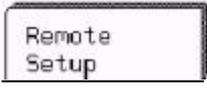
2.   GPIB   RS232   PC
          .

GPIB, RS232,   Network(   )   .
          .

RS232   RS232   7   8
          .   **RS232**   GPIB
          "talk-only"   .
          .

RS232   RS232 Parity   .

RS232   RS232   Bit
          .

RS232   RS232 Baud   .

GPIB   GPIB   .

1
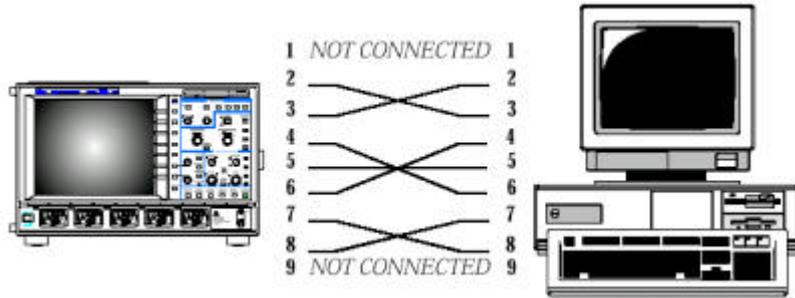
W wave**pro**

12-1. WavePro DSO   PC   RS232-9   .

ScopeExplorer   WavePro DSO   Windows
                                                 . (" 　　　　　　　　 "   .)

1.   GPIB(PC   GPIB   ), PC   RS232-C
   LAN(   )   PC   .

2. http://www.lecroy.com/scopeexplorer   ScopeExplorer   .
        LeCroy   .

3. ScopeExplorer   Windows   ScopeExplorer   .
                                                          .

.
                             .   PC   WavePro DSO   .

.   .

.
                        .
        (.)

· WavePro DSO   PC
                                   .

     Windows   Windows
               .

· WavePro DSO   .
                                                                    .

·   PC   LeCroy   Microsoft   Excel
        Mathsoft   Mathcad   PC   ASCII
        (12-4   ).

WavePro DSO 和 PC

VavePro DSO Remote Control (RC) Assistant　　　　　GPIB, RS232,　　LAN
　　　　　　　　　　　　　　　. RC Assistant　　　　　　　PC
　　　　　　　　　　　. RC Assistant　　　　　　　　　　　PC
　　　.
　　. , "Remote Control: problem detected and logged."

UTILITY

1. 　　　　　UTILITIES　　　　　　.

Special
Modes

Remote Ctrl.
Assistant

2. 　　　　.

3. 　　.

Off —RC Assistant　　　　　　　　　　　　　　.

Errors Only —
　　　　　　　　　　(　　　　　　　　　　).

Full Dialog —
　　　　　　　　　　　　　100　　　　　　.
　　　"　　　"　　　　　.

RS232 Also —　　　　　　　RS232
　　　　　.
　　GPIB　　　　　.
(　　　COMM_HELP and COMM_HELP_LOG
.)

Turn to
Scroll Log
Push to Clear

4 　　　.

wavepro

ASCII

WavePro DSO (M, M2, M3 M4) LeCroy
. ASCII , PC
.

Math PC .

LeCroy 10-20
. 1 ASCII 13-15 MB .
ASCII .

WavePro DSO ASCII . , Spreadsheet,
Mathcad MATLAB .
. ASCII
.

FORMAT	HEADER	TIME VALUES	AMPLITUDE VALUES	SEQUENCE TIMES	MULTI-SEGMENT	DUAL ARRAY
	header .	.	.		.	(FFT) .
Spreadsheet						
Mathcad						
MATLAB						

WavePro DSO PC

ASCII

ASCII   PC   .
Spreadsheet   ASCII   .   PC   .

WAVE
STORAGE

1.   .

—to—
M1 M2 M3 M4
Card Flpy HDD

2   .

STORE W'FORMS
—Data Format—
Binary ASCII
(Spreadsheet)

Setup ASCII
Format

—Auto-Store—
OFF
Wrap Fill

DO STORE
(1->Flpy)

—store—
1 2
3 4
A B
C D
All displayed

—to—
Card Flpy HDD

3.   /
ASCII   .

ASCII   .

ASCII   .

. Wrap
'   '
. Fill   .

.

.

.

(Flpy)   WavePro DSO
PC   (Card)   PC

.

VP-OM-E Rev A   ISSUED 2001   12   12-5
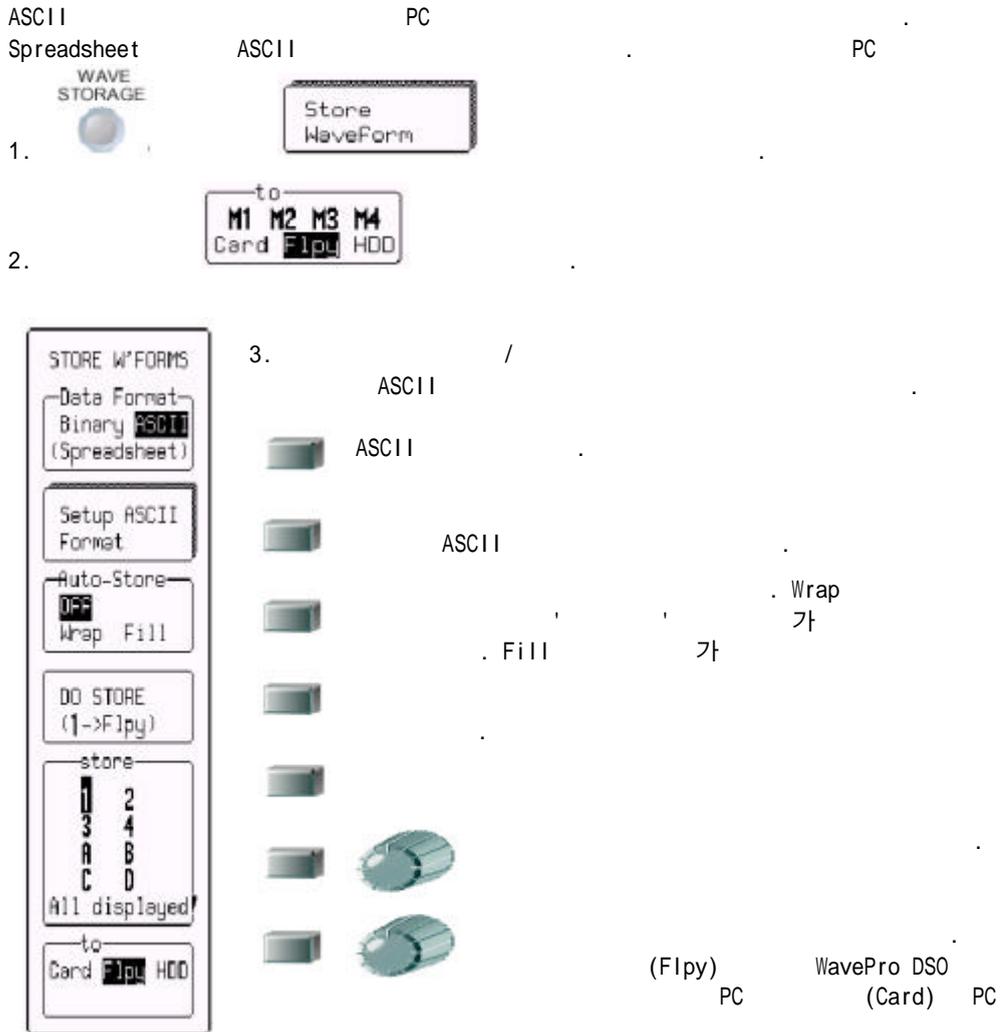
ASCII SETUP
Data Format
Spreadsheet
MathCad
Matlab

/
ASCII   .

ASCII   .

STORE W FORM
                    .

ASCII

Spreadsheet

Spreadsheet Microsoft Excel

`. File -> Open` :

12-2
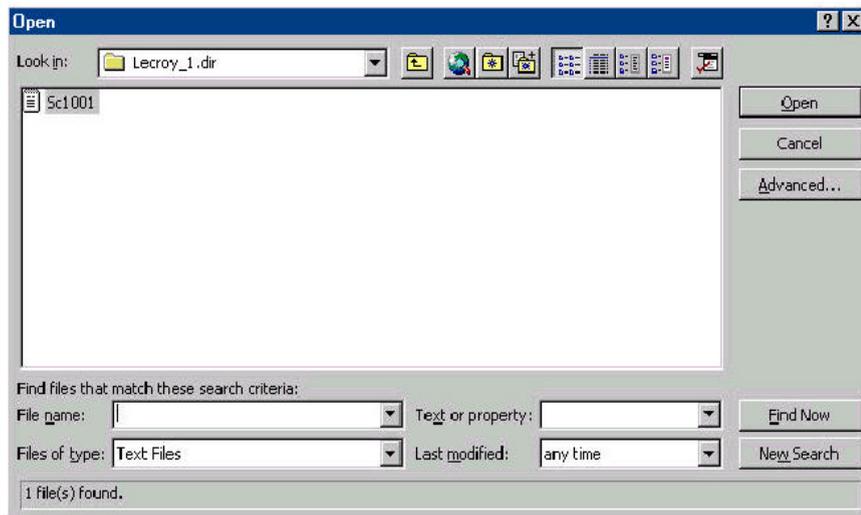
Excel

(LeCroy WavePro DSO).

1. **Delimited** .

2. WavePro DSO Spreadsheet
   "." .
   Comma .

3.
   . **General**
   Column ( ) .

4.   Finish   .   .

12-3

Spreadsheet

X

(6).

12-4

Spreadsheet

.

.

$SegmentStartRow := (DesiredSegment * D2) + B2 + 5$

$SegmentEndRow := SegmentStartRow + D2 - 1$

$TrigTime = INDIRECT(ADDRESS(DesiredSegment + 3, 2, 4))$

$TimeSinceFirstTrig = INDIRECT(ADDRESS(DesiredSegment + 3, 3, 4))$

WavePro DSO

.

Mathcad

Windows MathSoft Mathcad .

.

12- 12 .

Mathcad Versions 3.1 - 7 .

$$A := \text{READPRN(file)}$$

$$K := \text{last}\left(A^{\langle 0 \rangle}\right)$$

$$A := \text{submatrix}(A, 2, K, 0, 1) \qquad \textbf{Create a submatrix containing data but no header}$$

$$t := A^{\langle 0 \rangle} \qquad \textbf{Extract time vector}$$

$$v := A^{\langle 1 \rangle} \qquad \textbf{Extract amplitude vector}$$

$$K := \text{last}(t) \qquad \textbf{Determine index of last point}$$

$$k := 0 .. K - 1 \qquad \textbf{Create a ramp}$$

12- 5

Mathcad

Read data from file

$a := \text{READPRN}(sc1000)$

Extracting the first segment only (or only segment if not sequence trace)

$n := \langle 1 + a_{0,0} \rangle \cdot \langle a_{0,0} + a_{0,1} \rangle$

$m := 0 .. 1$

$\text{firstseg}_{n-1-a_{0,0}, m} := a_{n,m}$

$$n = \begin{bmatrix} 3 \\ 4 \\ 5 \end{bmatrix}$$

$$\text{firstseg} = \begin{pmatrix} 1 & 1 \\ 1.1 & 2 \\ 1.2 & 3 \end{pmatrix}$$

$$a = \begin{bmatrix} 3 & 3 \\ 1 & 0 \\ 2 & 999 \\ 1 & 1 \\ 1.1 & 2 \\ 1.2 & 3 \\ 1 & 1.1 \\ 1.1 & 2.1 \\ 1.2 & 3.1 \end{bmatrix}$$

Extracting a given segment

$\text{numsegments} := a_{0,0}$ Total number of segments in trace

$\text{seglen} := a_{0,1}$ Number of samples in each segment

$\text{segment} := 0$ Desired segment number

$\text{segstart} := 1 + \text{numsegments} + \text{segment} \cdot \text{seglen}$ Index of first point in segment

$\text{segend} := \text{segstart} + \text{seglen} - 1$ Index of last point in segment

$\text{segtime} := a_{\text{segment}+1, 1}$ Segment trigger time

$x := a^{\langle 0 \rangle}$

$y := a^{\langle 1 \rangle}$

$i := \text{segstart} .. \text{segend}$

12-6

Use MATLAB

Windows   MathWorks   MATLAB Version 4.2c.1   .
                              MATLAB   .
                                                      (   )
                    ("   1 ").

MATLAB   .   .
                                    .
            .

§ § §
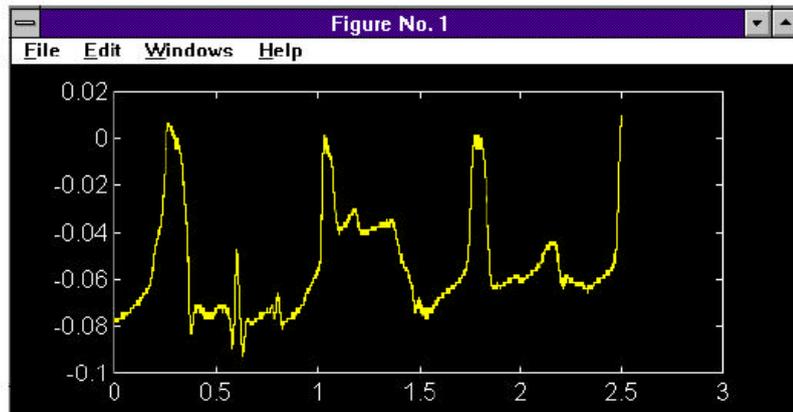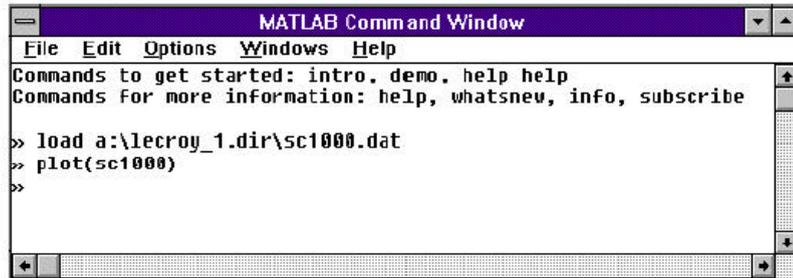
3
WAVE ANALYZER PRO
(WAVAPRO OPTION)

13 :

.

.

WavePro DSO　　　　　WaveAnalyzer Pro

　　　　. WAVAPRO　　　　　　　　　　　　　　　　　　　　　. , WaveAnalyzer, Jitter
and Timing Analysis (JTA)　　Digital Filter Package (DFP)　　　　　　.
JTA　DFP　　　　　　　　　　　　　　　　　　.

WAVAPRO

　　　　　　　　　　　　　　　　　　　　　　　　　　　.

•　　　,
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　(4　　11
　　).
　　　　　　　　　　　　　　　　　　.

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　.

　　　　　　　　　　　　　　　　　　.

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　. WAVAPRO
　　　　WavePro DSO　　　　　　　　　　　　　　　, 　　　, 　　　　,
　　　　　　　　　　　　　　　.

　　　　　　　　　　　　　　　　　　　.

MEASURE

1.　　　　　　　　　　MEASURE　　　　　　.

mode
Std Voltage
Std Time
Custom
List by nT
Pass

2.　　　　　　　　Parameters　　　　　　　　　　　　　　　　　　　　.

statistics
OFF　On

　　　　　　　　　　　　　　.

```
┌─From─────────┐          ┌─to──────┐
│ 0.00 div     │          │ 10.00 div │
│ Track ▐OFF▌ On │          │           │
└──────────────┘          └───────────┘
```
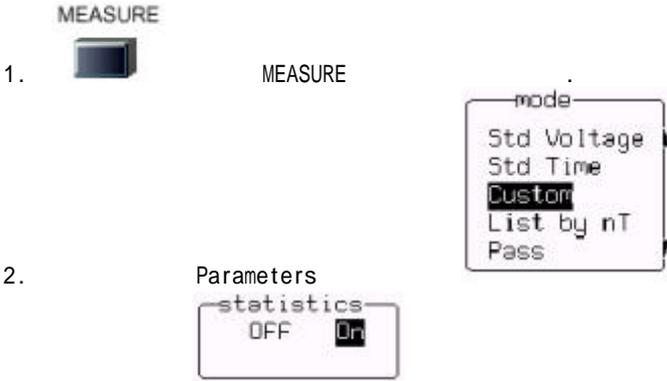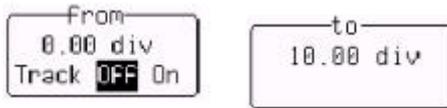
3.   .

          (13-1,   *).   **from   to**
                                        .

202.442 kHz   **freq**   (*)   .
                              201.89 kHz (*)   .   ,
                                    .

13-1

```
┌─────────────┐
│ CHANGE      │
│ PARAMETERS  │
└─────────────┘
```

4.   CHANGE PARAM   .

13-2
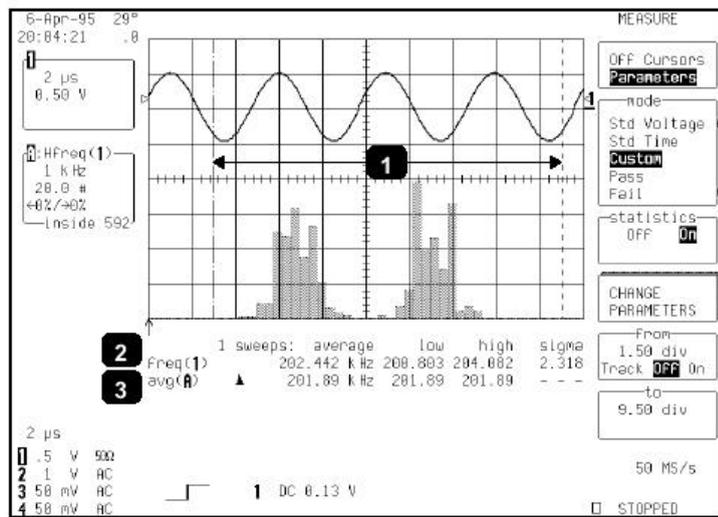
1 "Cyclic" freq measure Line 1 freq(1) (*)
. Trace A "Statistics" avg measure Line 2
. avg * "avg(A)"
(*) Trace A .
"Category" "measure" . Lines 3 ~ 5
.

5. " measure " . "On line"
.

13-2

SETUP . **DELETE**
ALL PARAMETERS .
.

"statistics"

(   )
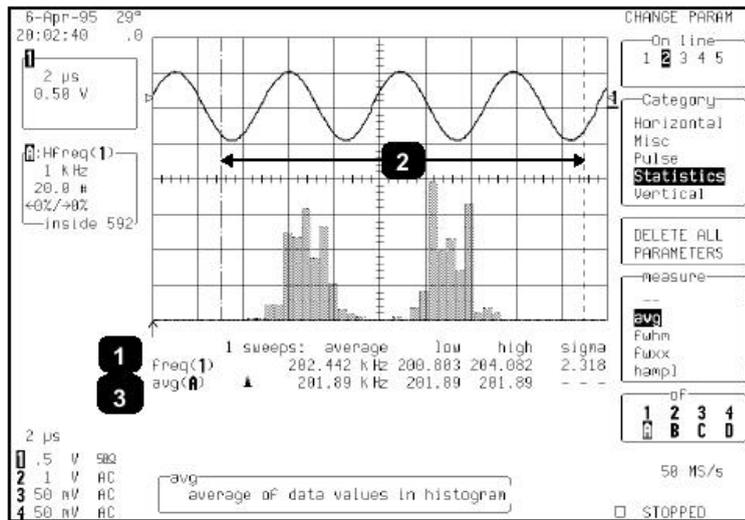
(M,   M2, M3   M4)

"All Segments"   . *"statistics"*

. *"All Segments"*

"statistics"   *(Delay*
Dt@Iv), CLEAR SWEEPS   .

"All Segments"   ,

50   .
"Statistics"
.   *"Statistics"*   ,   ,

13-3 .

.

.

13-3

4000 Hz .

. .

.

.
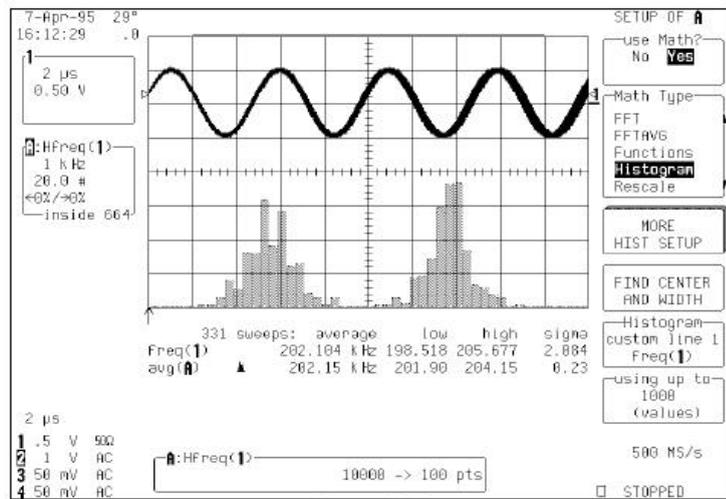
13-4

*(*)*   *. Displayed Trace Field   *

.

13-4
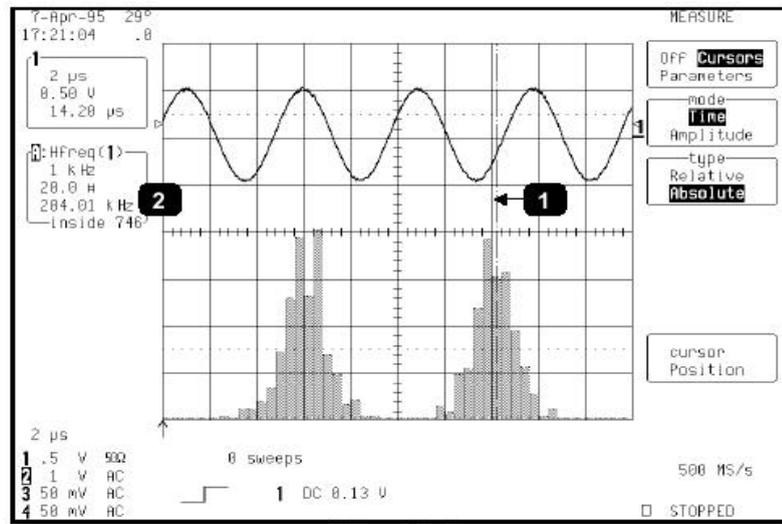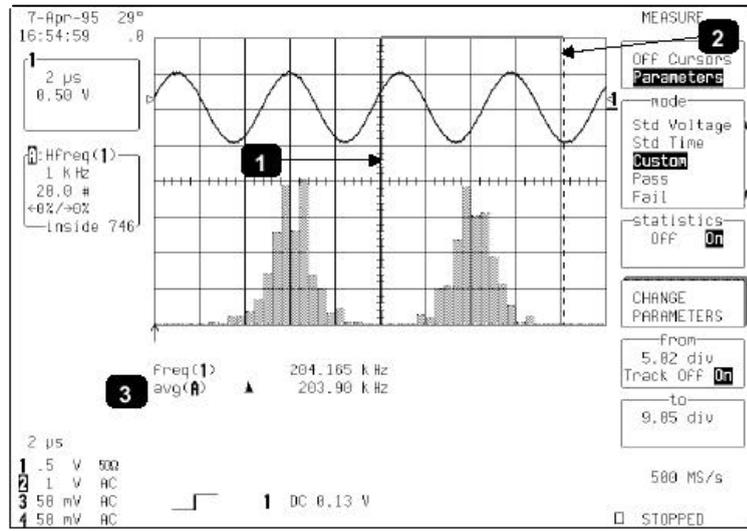
13-5

13-6

(*   *)   . *Displayed Trace Field*

kHz   *   .
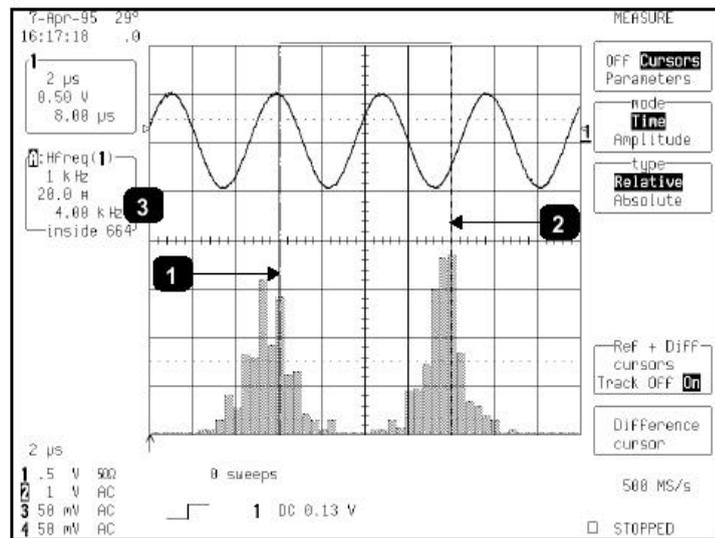
13-6

§§§

14 :

.
.
.
.
.
.

A, B, C   D   Math   .
Trace A   .
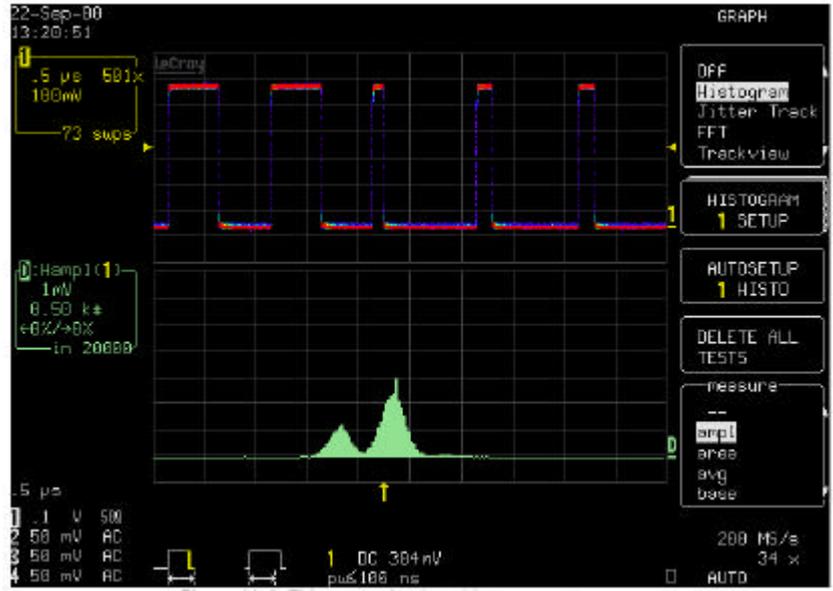
GRAPH

1.   Wavepilot   .
                                                                   .

                          14 1.   .

wavepro

WavePro DSO (Channel 1) .

1. CHANNEL 1 *WavePro* DSO .

ZOOM

2. Trace A Channel 1 .

—use Math?—
No **Yes**

SETUP

3. .

SETUP OF **A**

—use Math?—
No **Yes**

—Math Type—
Functions
Jitter
Histogram
O.R. Data
Per.Hist

MORE
HIST SETUP

FIND CENTER
AND WIDTH

—Histogram—
custom line 1
avg(**A**)

—using up to—
1000
(values)

4. .

Yes .

Histogram .

( ).

.

.

. 20

.

:

POSITION **ZOOM** .

HISTOGRAM A

Setup
Binning
Scale

. **Binning**
.

: "Center" "Width"

.

POSITION

. (

MEASURE TOOLS .)

PARAMETER SETUP

CHANGE PARAM

. 11 "

" .
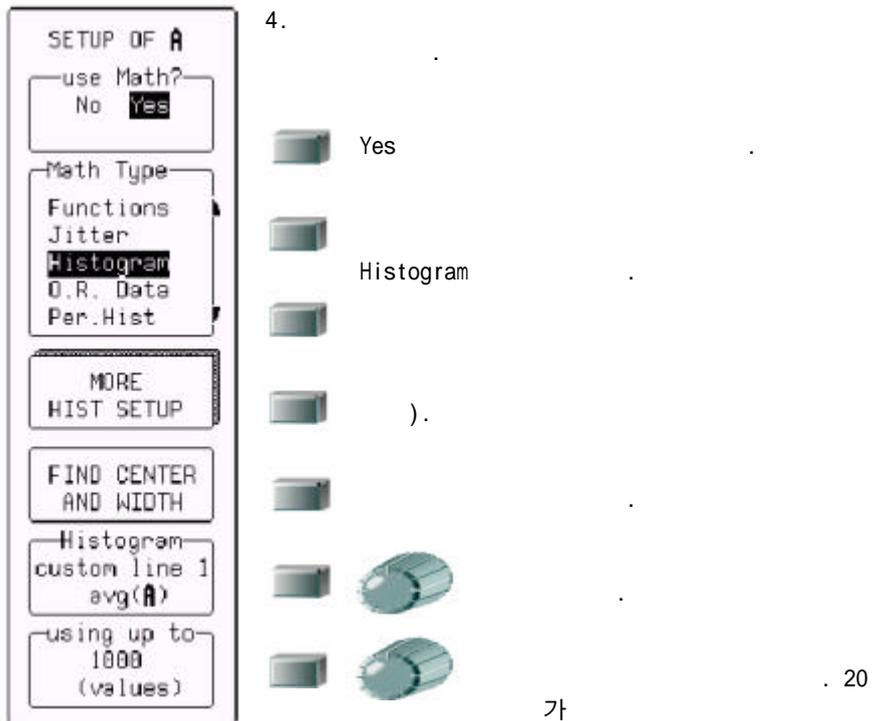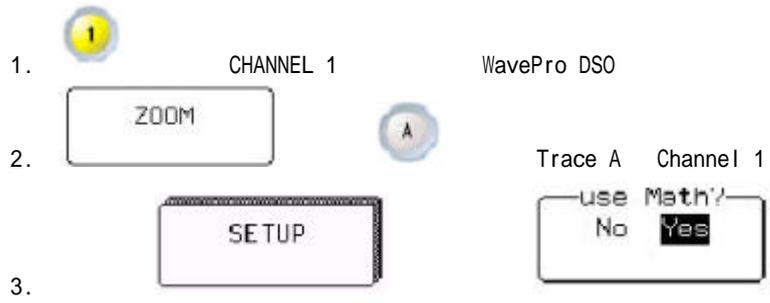
FIND CENTER AND WIDTH

.

classify into 2000 (bins)

.

Scale
(14-8   ).

. **Linear**   , **Log**
, **LinConstMax**

.

WavePro DSO

.

.

.

.

(10)
"Center"

.
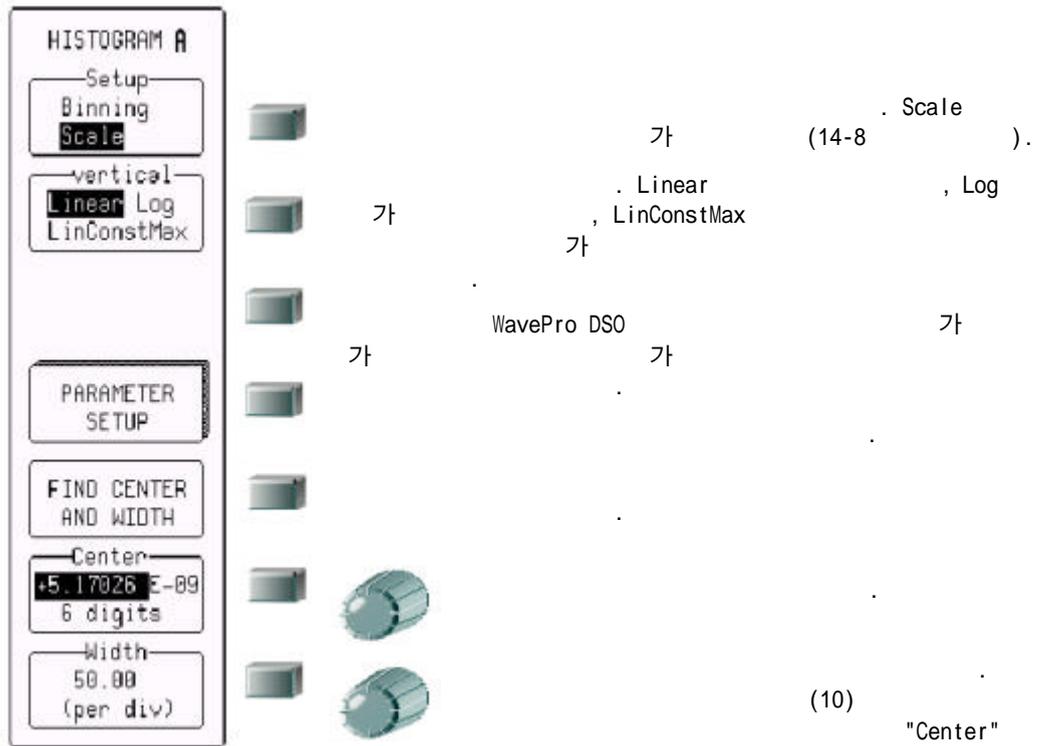
图 14-2 中的 "Math Type" 菜单设置为 "Histogram"
。   。
"Histogram custom line" 菜单项设置   。


```
25-Apr-95  29°                              SETUP OF A
15:48:50   .0                             ┌use Math?─
┌─┐                                        No  Yes
│1│                                       ┌Math Type─
 2 µs                                      FFT
 0.50 V                                    FFTAVG
                                       1   Functions
                                           Histogram
                                           Rescale
                                          ┌────────┐
                                          │  MORE  │
                                          │HIST SETUP│
                                          └────────┘
                                          ┌────────┐
                                          │FIND CENTER│
                                          │AND WIDTH │
                                          └────────┘
                                          ┌Histogram─
                                          custom line 1
                                            Freq(1)
                                          ┌using up to─
                                             1000
                                            (values)
 2 µs
 1  .5  V  50Ω
 2  1   V  AC     ┌A:Hfreq(1)──┐         500 MS/s
 3  50 mV  AC     │10000 -> 100 pts│
 4  50 mV  AC     └──────────┘         □ STOPPED
```

图 14-2
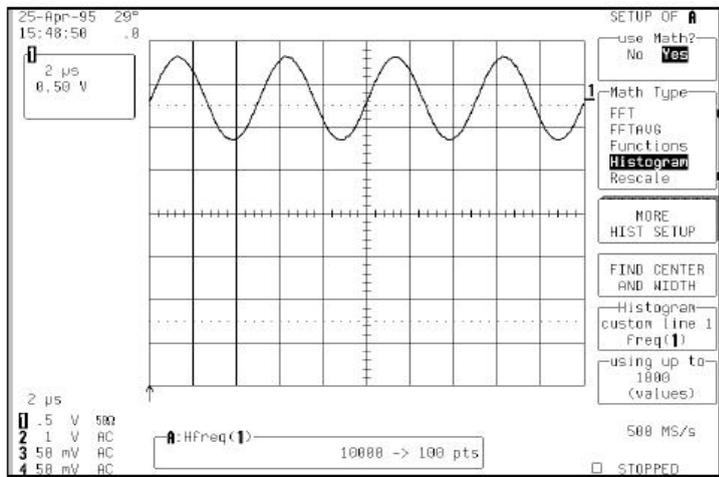
。 "using up
to"   。
                          20   20
      (WAVAPRO   ).

5.   14 3   .

14 3

.

.

.
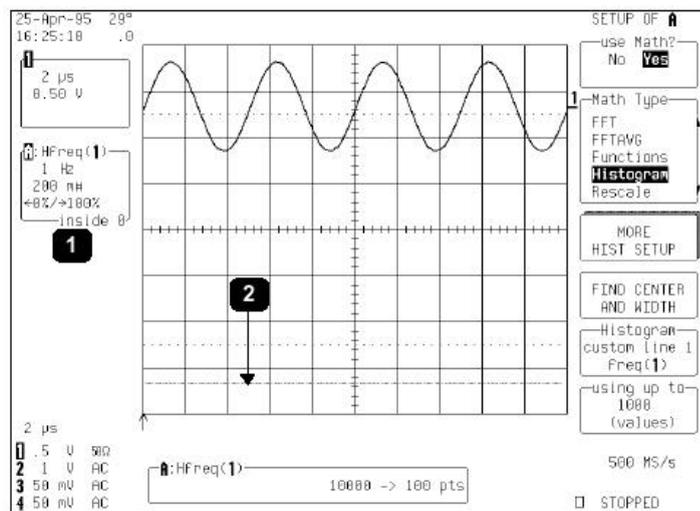
                                                                          Displayed

trace   (*)   .

•   ("1Hz").
                                                                         .

•   #   ("200 nH).

•   ("inside 0')

                          ("¬0%)

•   ("100%®")

100%

.   (*)   .

"FIND CENTER AND WIDTH

                                    . "using up to"   (
          20000   20000   ).   14-4
          .

14-4

                                                                                                                                                          .

RESET

                                                                                                                                                          .
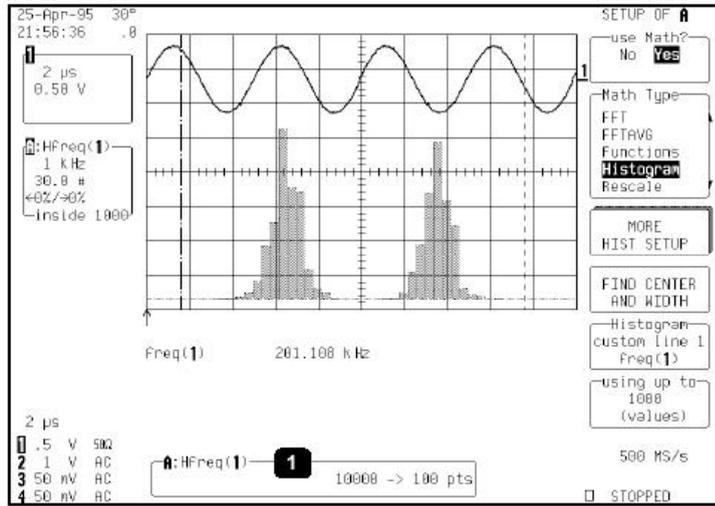
                    Information Window(*)   Trace A   Channel 1
        ("A:Hfreq(1)"   )   .   "1000 ?100 pts"   Channel 1
          1000   100
          .

"Setup"   "Binning"   "Scale"   .
"Binning"   "classify into"   .

                                                                1-2-5   20
2000   .

"Setup"   "Scale"   4-5   .
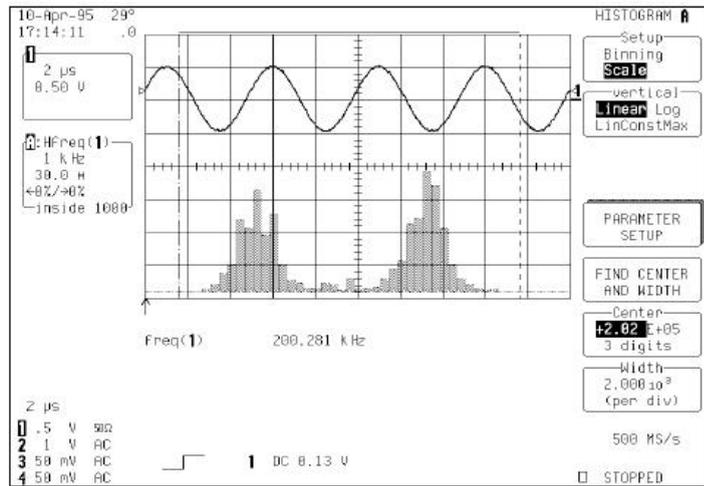
14-5

                                    "vertical"   .

· *Linear*   .   *0*
            .
                    1-2-5   .

- **Log**   (14-6). '0'
                             .
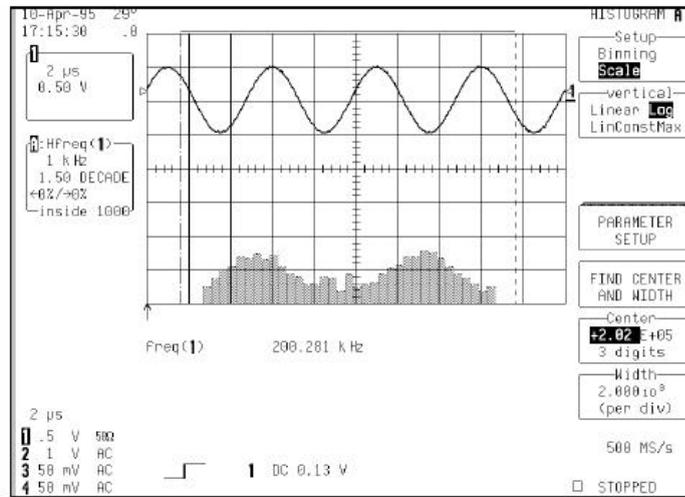
14-6

· **LinConstMax**

14-7
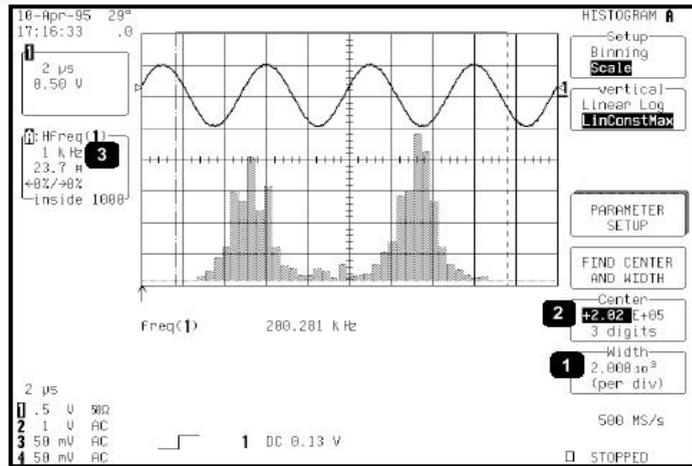
"Center" "Width"

(10)

"**Center**"

2.000 ?10 3 (ItemÊ)

(2 kHz/division) x (10 divisions) =
20kHz   , 2.02 E+05 Hz (Ë)   .

202 kHz ±10 kHz   (192 kHz   212 kHz   )

20kHz   100   .

· 20 kHz / 100
·   0.2 kHz.

"Center"   (2.02),   (E+05)
(3)   . Displayed Trace Field
kHz/   *   .

.

.

202 kHz ±10 kHz   .
"Width"   1-2-5   .

.

MEASURE

1.   Wavepilot   "mode"   Custom   .

CHANGE
PARAMETERS

1.   CHANGE PARAM   (
14-8).


```
10-Apr-95  29°                                    CHANGE PARAM
17:19:50   .0                                    ┌─On line─┐
                                                 1 2 3 4 5
  2 µs
  0.50 V                                         ┌─Category─┐
                                                  Horizontal
 A:Hfreq(1)                                       Misc
  1 kHz                                           Pulse
  30.0 #                                          Statistics
 ←0%/→0%                                          Vertical
 └inside 1000┘
                                                 DELETE ALL
                                                 PARAMETERS
                                                 ┌─measure─┐
                                                  low
                                                  maxp
                                                  mode
                                                  pctl
                                                  pks
   freq(1)       200.281 kHz
 1 maxp(A)   ▲      110 #                         ┌─of─┐
   mode(A)   ▲   203.90 kHz                       1  2  3  4
                                                  A  B  C  D
  2 µs
 1 .5  V   50Ω                                    500 MS/s
 2 1   V   AC    ┌─mode─────────────────────┐
 3 50 mV   AC    │ most frequently occuring data value │
 4 50 mV   AC    └─────────────────────────┘        □ STOPPED
```
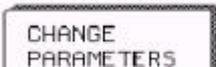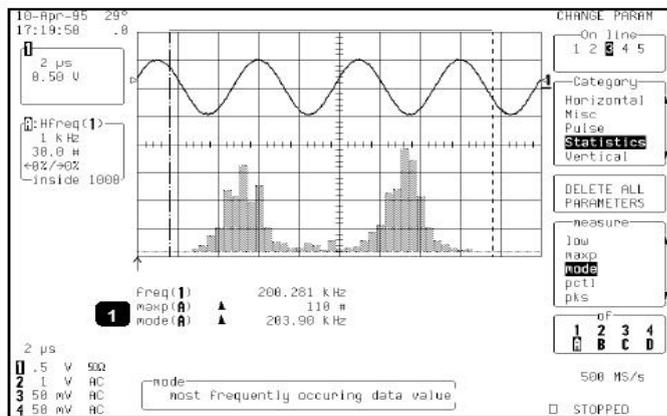
14-8

.

maxp   mode(item Ê)   .

.

![wavepro logo]

"maxp" "mode" "(A)" .   Trace A
                                         .   .

- "maxp(A)"   "110#"   110   .

-    (A)   "203.90 kHz"   ,   203.90 kHz   .

- "mode" "maxp"
                                                    .
                                                                        ' ---'
                    .

                    (4   )
            .   14-9   ("freq")
                                        "avg(A)" (ItemÊ)   .
(Ë)   "from" 4.70 divisions (Ì)   "to" 9.20 divisions (Í)

14-9

.

.   14-10
(*)   .   (*)   (*)
.

14-10

.

.
(*).

§ § §

15 :

.

· *ISO*
·
·
·
·
·
·

, ,

.

.

, .

, .

. TIL ±50V

4V±2.5V . 5V

. 50 5V/50 , , 0.1V/

. 1.5V 1.6V .

1.6V 1.7V .

,

. 'x'

'y' .

.

.

, . 15-1 4.3 ~

4.4V (TIL

).

15 1

3.0 ~ 3.1V . TIL 2.5V

.

.

DSO
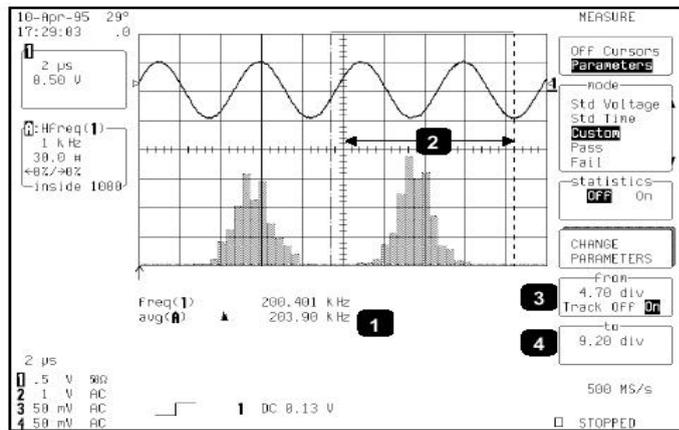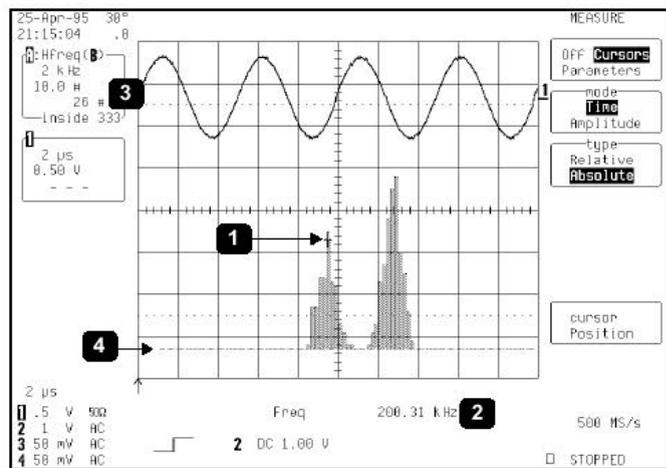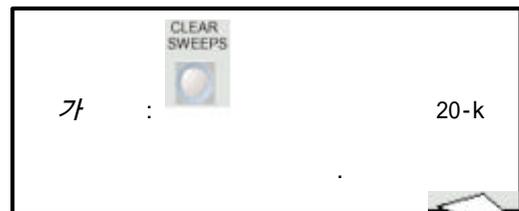
WAVA *WavePro* (DSO)

.   .

1.

2.

3.

4.

5.

.

.

6.

7.

8.

9.

10.

.
.
.
.
.

WavePro DSO   20000

.

' N   20000   /N

.   20000   ' N

.

' N   20000

.

.

WavePro DSO

(1, 2, 3

4)

(	)	
, , ,	49	
ampl, area, base, cmean, cmedian, crms, csdev, cycles, delay, dur, first, last, maximum, mean, median, minimum, nbph, nbpw, over+, over–, phase, pkpk, points, rms, sdev, dly, t@lv		
f@level, f80–20%, fall, r@level, r20–80%, rise	49	

.

.

.

.   ,
.   (   )
.   (   )
.   (   )

. "Category"   "Category"

(4   ) .

avg
fvhm   (   )
fwxx: x%   (   )
hampl:
hbase:
high
hmedian
hrms: rms
htop
low
maxp
mode:
pctl: ' x' %
pks:
range: .
sigma
totp
xapk: x

.

"All Segments"   .

                                .

                          .

:   15-2   5   0V   5V,
              .   .

                                      .

Volts

15-2

                                                      .

              .

                                                      .

                                    4   pks

        .

,   .
                                .
                                                    .
                                    .

                                .

                                            .

                        .

20000   .

        .
                                    .
                                                            .

§ § §
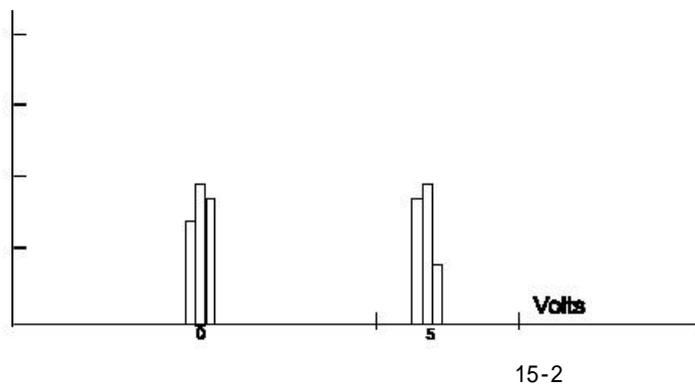
16 :

avg

:

:   .

$$\sum_{i=1}^{n} (\text{bin count})_i \, (\text{bin value})_i \; / \; \sum_{i=1}^{n} (\text{bin count})_i$$
,

                n bin count
                        bin value
            .

:
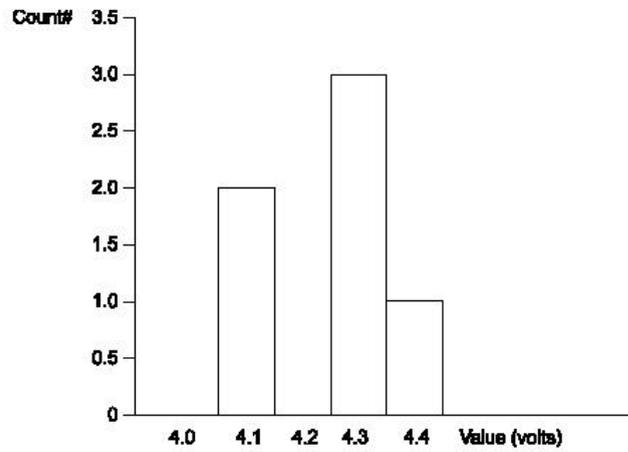
The average value of this histogram is: (4.1 * 2 + 4.3 * 3 + 4.4 * 1) / 6
= 4.25.

fwhm   50%

:   50%

.

.

:   (   )

(pks   ).

50%

.   50%

.   50%

.   **fwhm**   .

:

fwhm xx%

: xx%

                                           .

       .

: ( )
      (pks   ).
      50%
      .   50%
       .

xx%   .
      fwxx   .

: "CHANGE PARAM **fwxx** "MORE fwxx
SETUP"   .   ' xx'
0 100%   .

: 35% **fwxx**

hampl

:   .
        TIL   .
                hampl   ' 1'   ' 0'   .
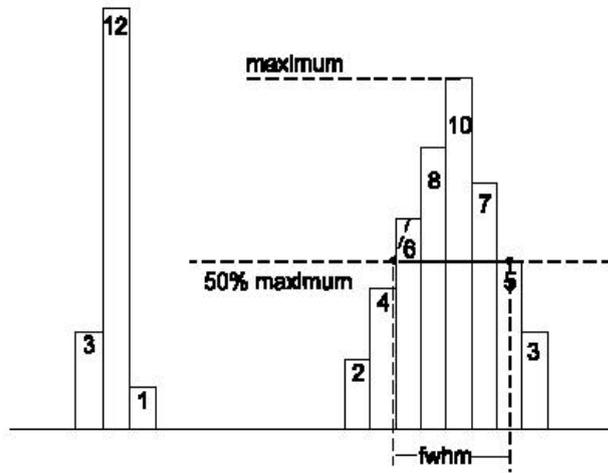
:   (   )
                                (pks   ).
                                        (**hbase**   )
                                        (**htop**   ).
                        .

                hampl = htop - hbase

:

                hampl   152 mV - 150 mV = 2 mV   .

hanpl

:   .

TIL

.   **Hbase**   ' 0   .

:   .

(**pks**   ) .

.   (

)   **Hbase**   .

:

high

:
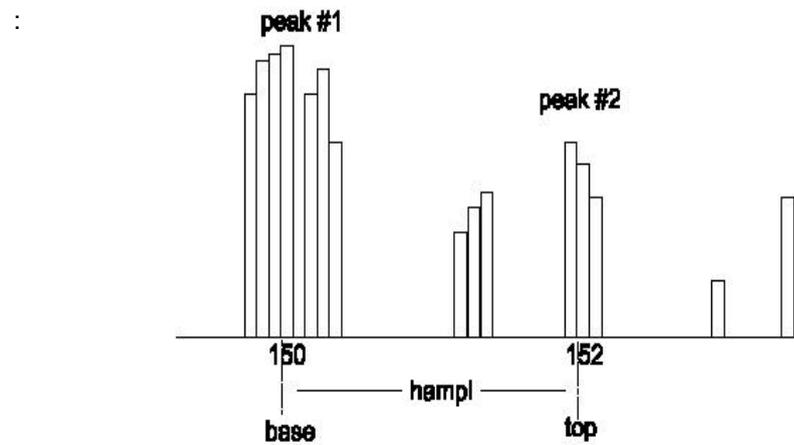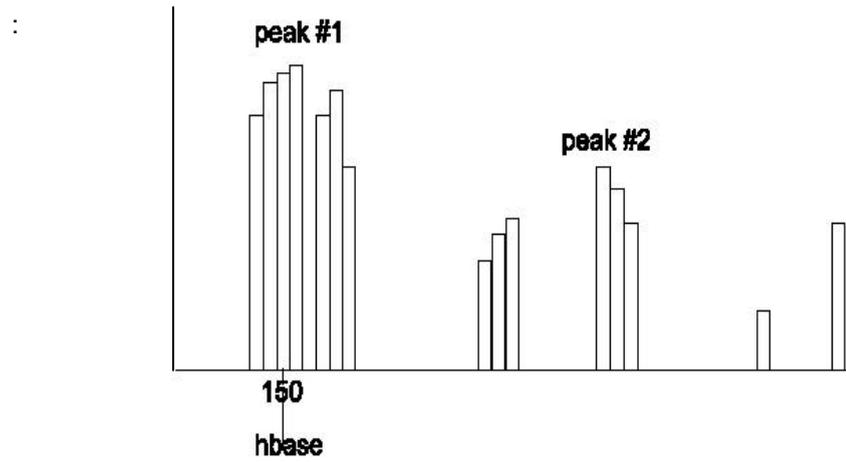
:   . **high**
                                                                     .

:
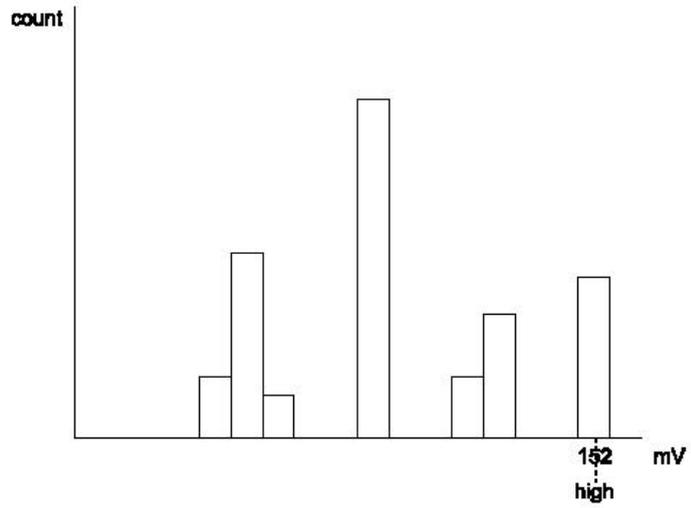
high 152 mV   .

hmedian

:   ' x'   .

:   .
                    50%   .
                                                                        .

                    hmedian   .

:   100   20
                    .   8   48   .
        9   8   6.1 ~ 6.5V   . 50%   100%
                                                            .

                    2   /8   = 0.25

        hmedian   .

        6.1   + .25 * (6.5 − 6.1)   = 6.2

hrms   Histogram

:   rms .

:   ( )   .

     hrms   .

:   **hrms**   .

$$hrms = \sqrt{(3.5^2 * 2 + 2.5^2 * 4)/6} = 2.87$$
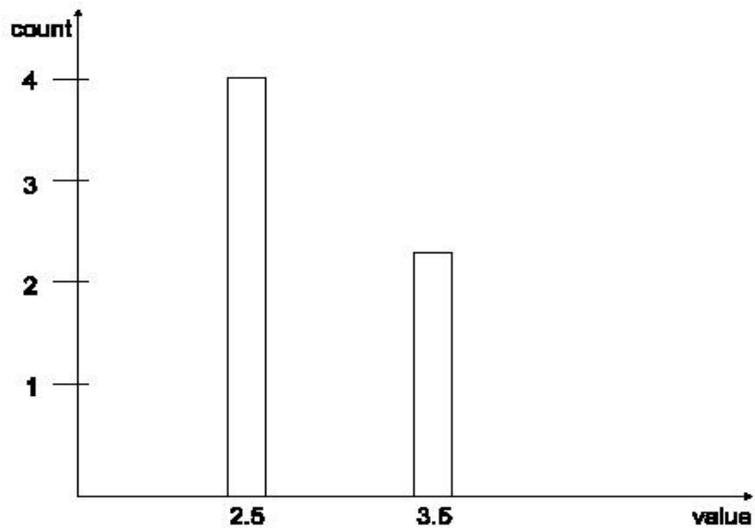
htop
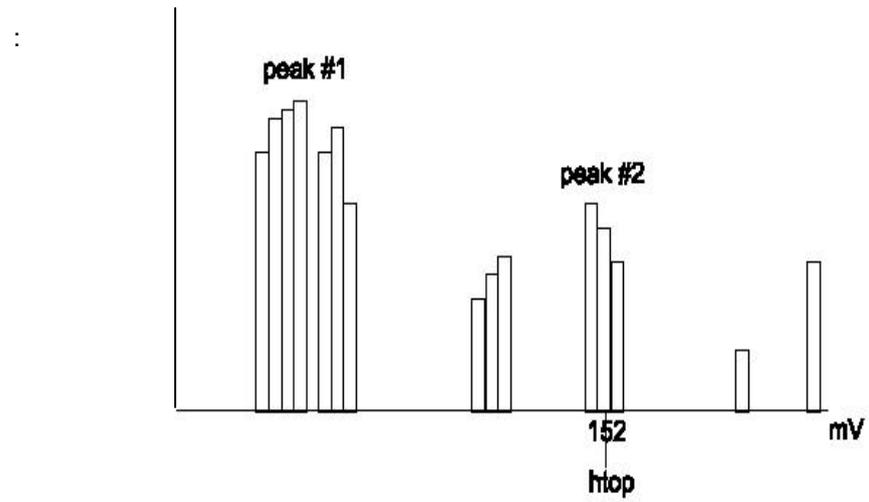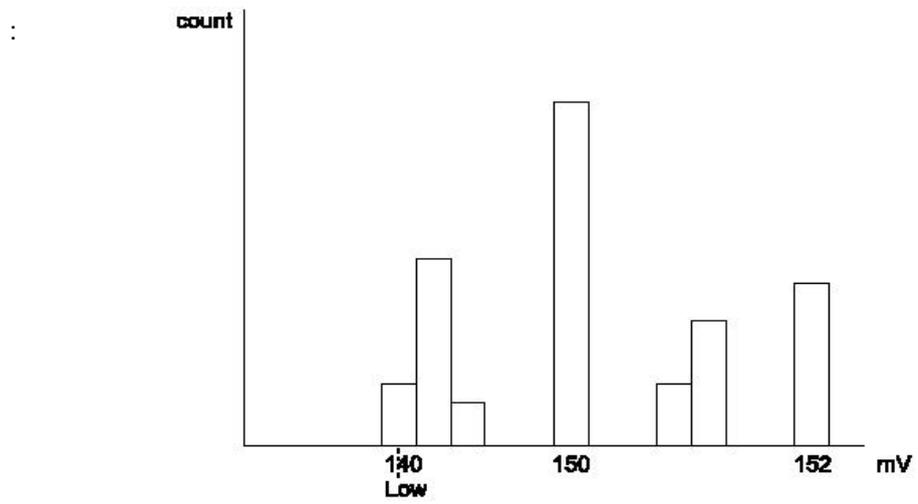
:   .

TTL

.   **htop**   ' 1'   .

:   .

.

htop   (

).

:

peak #1

peak #2

152

mV

htop

low

:

.

:

.

low .

:

low 140 mV .

maxp

:   (   ).

:   .
                                maxp   .

:

                    maxp   14   .

mode

:

: .

.

mode .

:

mode 150 mV .

Pctl

:   'xx'
                                                     .   50%

                 pctl   **median**   .

:   .

         xx%
         'xx' %   /

                 .

            pctl   .

:   100   20
       'xx'   25%   .   6   22   .
      9   6.1 ~   6.4V   .
       25%   .

         3   /9   = 1/3

         pctl   .

        6.1   + 0.33 * (6.4 - 6.1)   = 6.2

:   "CHANGE PARAM   **pctl**   "MORE pctl
SETUP"   .
         .   1%   100%
                 .

pks

:

:

           .

         3   .

11.   .
         (T1)   .   ,

12. T1= mean + 2 sqrt (mean).
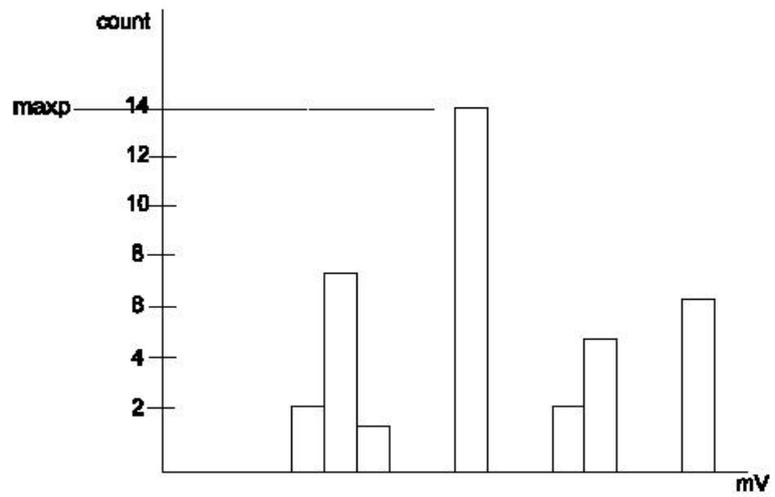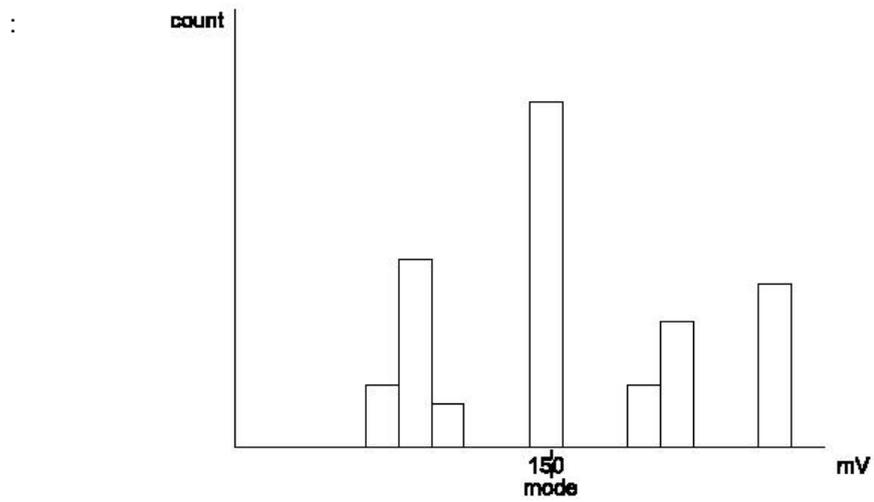
13.   T1   .
      ,

14. T2 = mean + 2 * sigma,

      T1   .

15. T2
         . T2   .
             T2
             .   1/100
   T2   1/100   T2
              .
             .
        1/50   .

:   **T2**
.

range

:   .

:   .
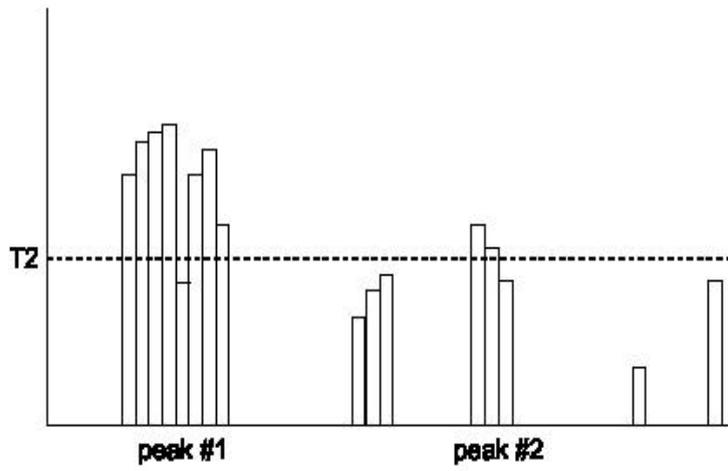
     range   .

:
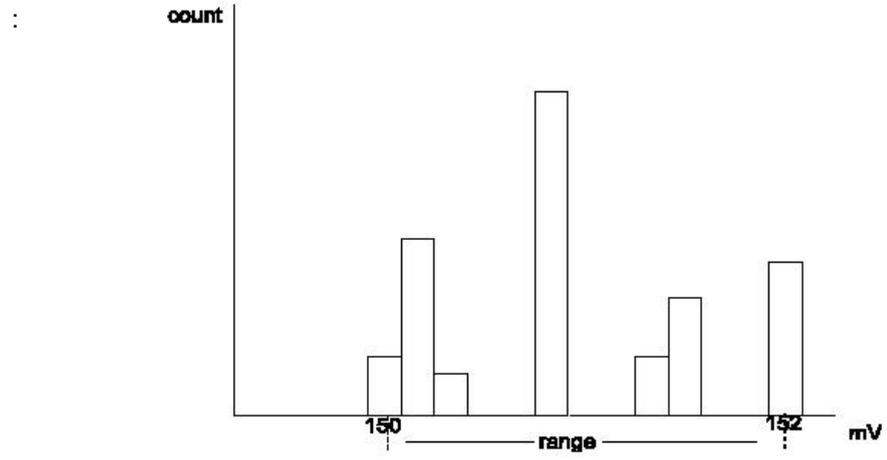
range   2 mV   .

sigma

    :

    :   **sigma**   .

$$= \sum_{i=1}^{n}[\text{bin count}_i * \text{bin value}_i] / \left(\sum_{i=1}^{n} \text{bin count}_i\right);$$

$$= \sqrt{\sum_{i=1}^{n}[\text{bin count}_i * (\text{bin value}_i - \text{mean})^2] / \left(\sum_{i=1}^{n}[\text{bin count}_i] - 1\right)},$$

       n   **bin count**

          bin value

         .

     :
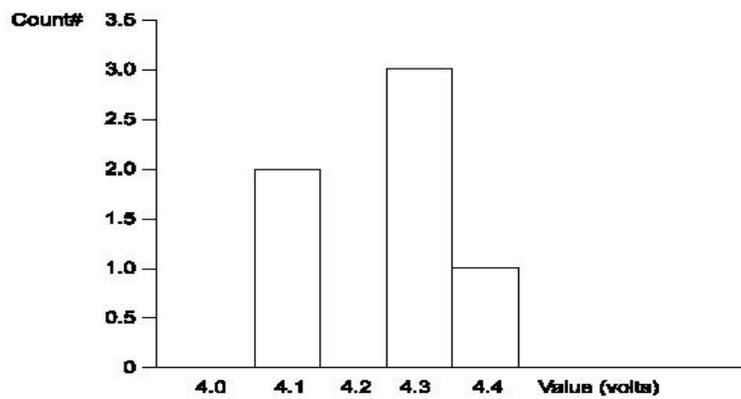
$$= (2 * 4.1 + 3 * 4.3 + 1 * 4.4) / 6 = 4.25$$

$$= \sqrt{(2*(4.1 - 4.25)^2 + 3*(4.3 - 4.25)^2 + 1*(4.4 - 4.25)^2) / (6-1)} = 0.1225$$

totp

: .

: .

:

9 .

xapk   xx   X

:   xx   .

:
                    (**pks**
).   n   (
)   **xapk**   .

:
                    (1).
                    (2).   (3).

§ § §

1

17 **:**

•

•

•

• *ScopeExplorer*

• *ActiveDSO*

10BaseT   LeCroy *WavePro* DSO
                                              .
                        .

                                WavePro DSO
        .

WavePro DSO   GPIB   .
        GPIB   .

                                                         IEEE 488.1
        IEEE 488.2 [1]   .

                TCP/IP   PC
        .   (crossover)
                                                          .

        (crossover)   .
                                                              .

---
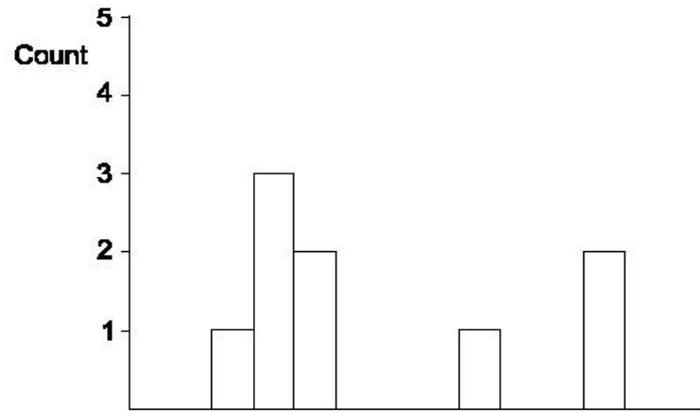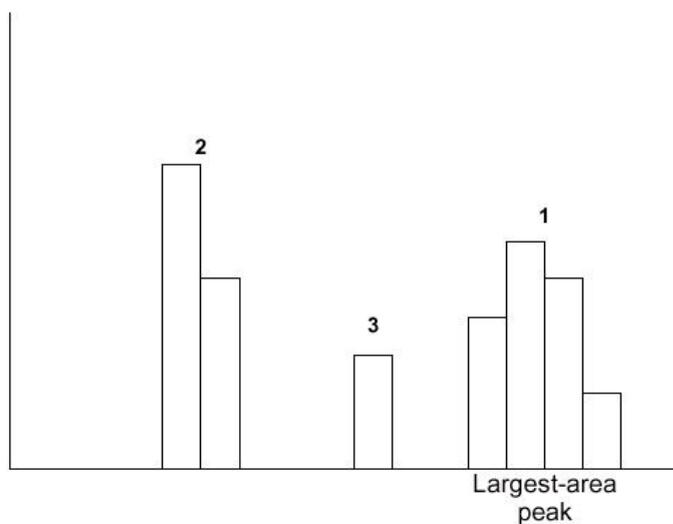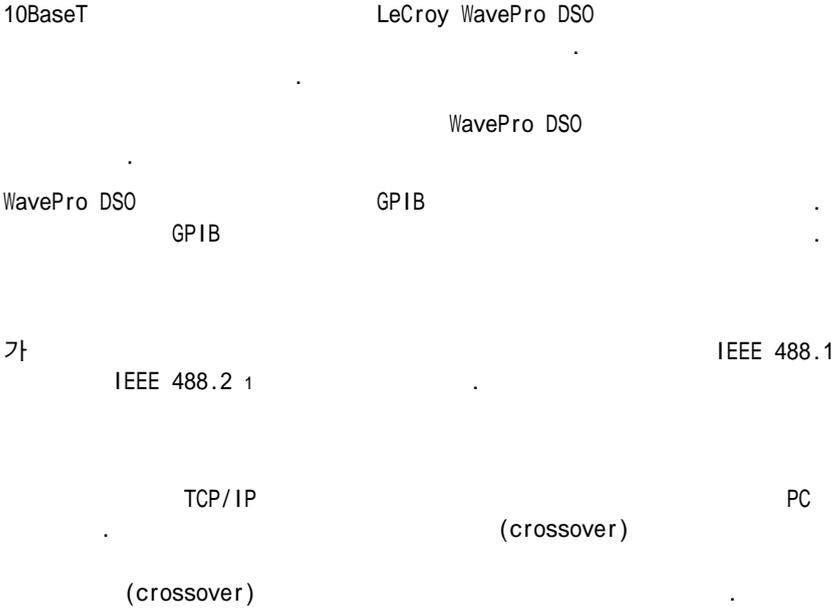
1. ANSI/IEEE Std. 488.2–1987, *IEEE*   ,   ,   . The
    Institute of Electrical and Electronics Engineers Inc., 345 East 47th Street, New
    York, NY 10017, USA

wavepro

ScopeExplorer

PC   , LeCroy   Windows 95/98   Windows
NT/2000/Me   .   CD-ROM
www.lecroy.com   .

Scope-Explorer   .

,
.

.

PC   Pixel-for-pixel
        .   Windows
        .
.

(**)**   **,**
                             PC
.
.
.

,   ,   **ASCII**

WavePro DSO   PC   LeCroy
Microsoft   Excel   Mathsoft   Mathcad   PC   ASCII
    .   LeCroy
ASCII   .

,   PC   (VDisk)
. GPIB   .

WavePro DSO   .
Windows   .
(:   *WavePro* DSO

.)

ActiveDSO

ActiveX™   ActiveX   Windows
                    LeCroy   . MS Office   ,
Internet Explorer, Visual Basic, Visual C++, Visual Java   Matlab (v5.3)   ActiveX
                                                        . ActiveDSO   CD-ROM
                www.lecroy.com   . ActiveDSO   GPIB
                                        .   Windows
                (GPIB, RS-232   Ethernet 10BaseT   ) ActiveDSO
                    .

·   Excel   Word   .

·   Microsoft Access Database   .

·   Visual Basic, Java, C++, Excel (VBA)   .

ActiveDSO
                                            .   10   VBA
(Visual Basic for Applications)   Excel
                                    .

            OLE   ActiveDSO
                                        .   Windows 95,
Windows 98   Windows NT   PC   .
                                            .

·   OLE Automation compatible Client(
    PowerPoint)
            .

·   (Visual Basic for Applications)
                                        VBA   .

VBA (Visual Basic for Applications)   Windows
                                .   OLE Automation Servers   ActiveX Controls
                    Visual Basic   .

W wavepro

VBA   WavePro DSO
                                    .

```
Sub LeCroyDSOTest()
    Dim o As Object
        Set o = CreateObject("LeCroy.ActiveDSOCtrl.1")
    Call o.AboutBox ' Present the control's About box
    Call o.MakeConnection("IP: 172.28.11.26) 'Connect to device on LAN
    Call o.WriteString("BUZZ BEEP", True) ' Make the DSO beep
End Sub
```

                    :

Boolean controlName.WriteString

WriteString   .

Control name	ActiveDSO
TextString	String, Text
EOI	Boolean, TRUE = EOI

Returns: ,   .

Remarks: .

EOI   TRUE   .
        .

EOI   FALSE   EOI   TRUE
                                    .

§ § §

18 ： *PC*

·

· *PC* *WavePro DSO*

· *PC*

·

·

· *IP*

WavePro DSO

WavePro DSO 는 PC 와 10BaseT Ethernet
. Windows 95, NT, 2000 및 Mac
.

LAN 은 18-1 .
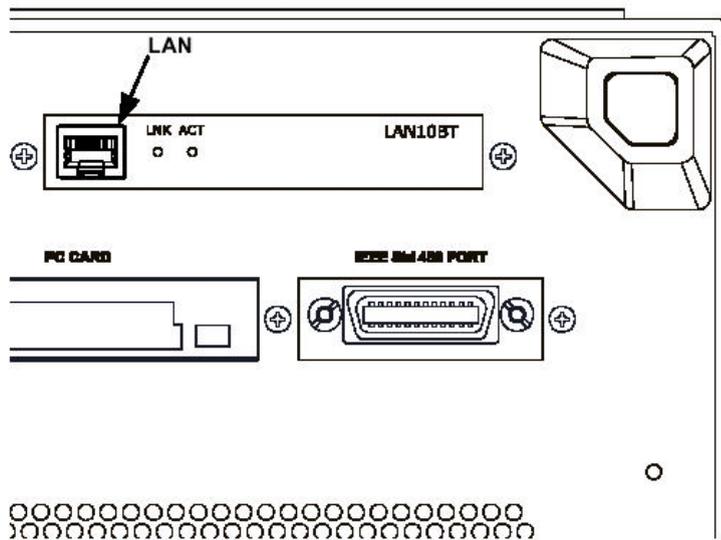
18-1. WavePro DSO

- *IEEE 802.3 Ethernet*
- *10BASE-T*
- *LED*

  LNK .
  ACT .
- · *WavePro DSO* LAN .

W wavepro

PC

WavePro DSO   PC   .

- *Pentium PC*

- *32 MB RAM*

- *10 MB*

- *Windows 95   Windows NT*

- *RJ45   10BaseT   Ethernet Adapter*

WavePro DSO   10BaseT Ethernet   .
                                                                    .
                    . PC   (crossover)
                                                          .

WavePro DSO   IP   .   Dynamic Host
Configuration Protocol (DHCP)   .
   IP   .

                    IP   . **172.25.1.26**

                                              . **255.255.0.0**

                                                  . **172.25.0.1**

PC

PC   *WavePro* DSO

WavePro DSO
.

IP

1.   UTILITIES   . "Utilities"   .

2.   **Remote Setup**   .
"REMOTE SETUP"   .

3.   **Network Setup**
. "TCP/IP Network Setup"
.

.

PC

：
PC Windows™ 95
. Windows NT
.
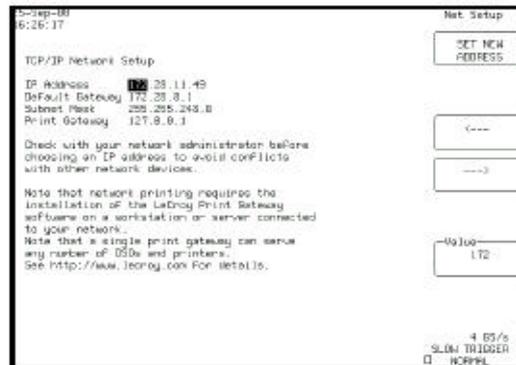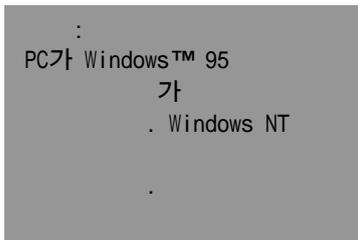
PC   . "   "
                              TCP/IP   .
            DHCP   IP   PC
                                                .

Windows 95   PC
1.   →   →   .
2.   .
                                                        .

3. TCP/IP   .
   TCP/IP   .

4.   .   .

                                     .

5.   .
   TCP/IP   .

6.   IP
         . 172. 25. x. x   255. 255. 0. 0   .
                                    (
)   .
              .

7. TCP/IP

[OK]
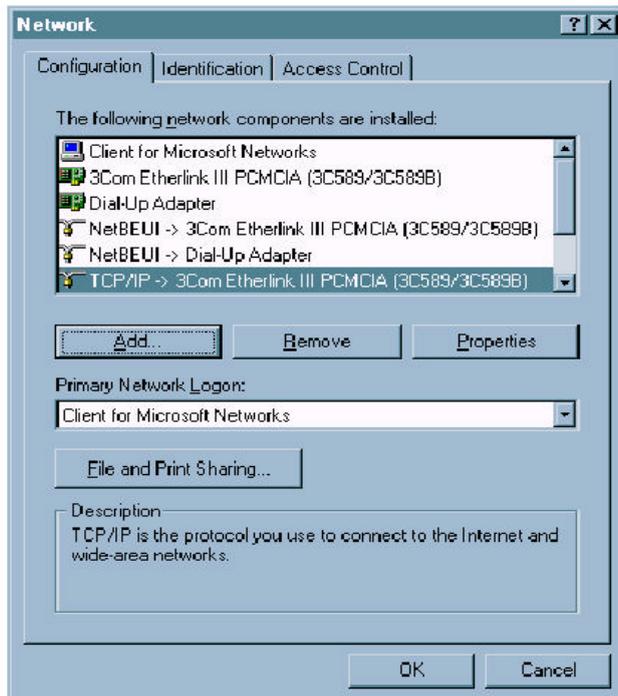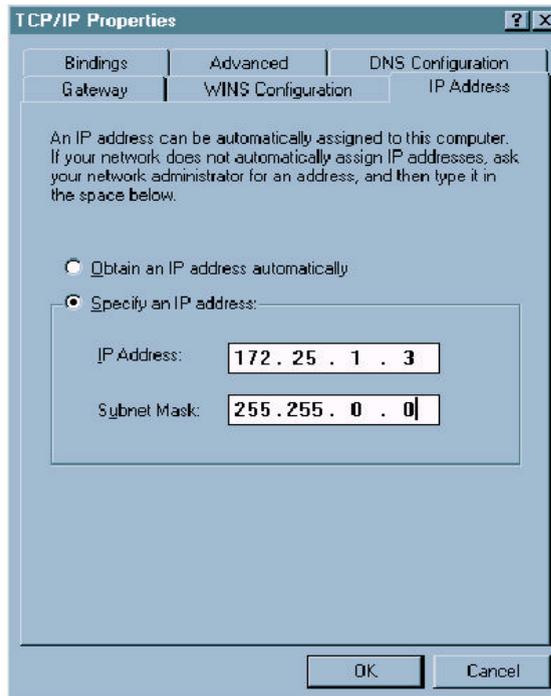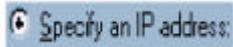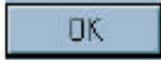
1.   (crossover)   (   )   PC   .
2.   .
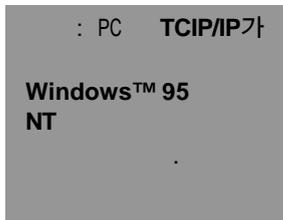
PC   TCP/IP   TCP/IP
Windows™ 95   Win-dows™ NT
" "   . PC

| : PC   TCIP/IP |
| Windows™ 95 NT |
| . |

                    .

3.   MS-DOS Prompt   .

4.   <ip_address>   .   <ip_address>
                                    .
                                    " "
                                                        .

                                    IP
172.25.1.2   .
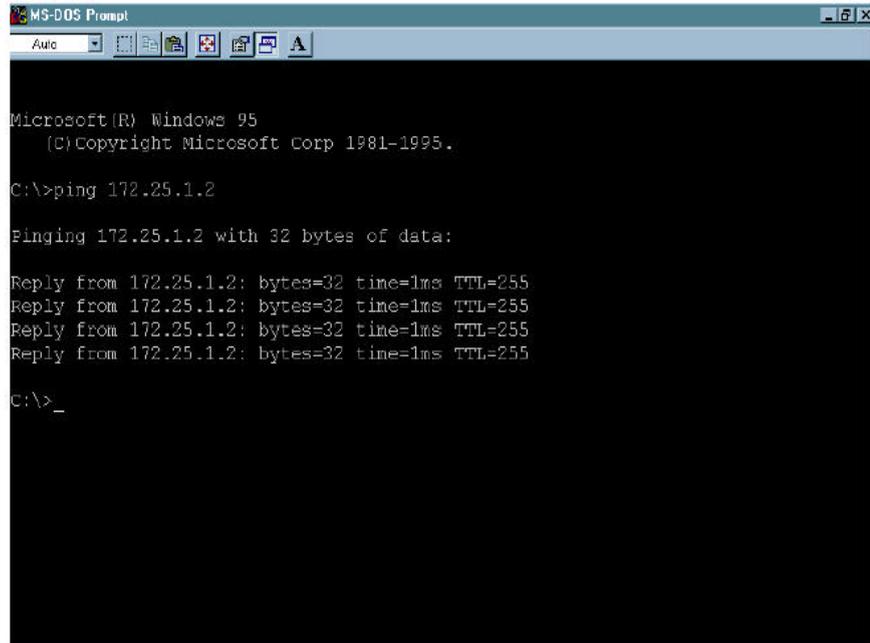
```
MS-DOS Prompt

Auto

Microsoft(R) Windows 95
   (C)Copyright Microsoft Corp 1981-1995.

C:\>ping 172.25.1.2

Pinging 172.25.1.2 with 32 bytes of data:

Reply from 172.25.1.2: bytes=32 time=1ms TTL=255
Reply from 172.25.1.2: bytes=32 time=1ms TTL=255
Reply from 172.25.1.2: bytes=32 time=1ms TTL=255
Reply from 172.25.1.2: bytes=32 time=1ms TTL=255

C:\>_
```

.

(   )   **IP**

PC   IP   .

.

.

.

.

.

:   "172. 25. 0. 1"   .

.

IP

IP   .

.

§ § §

PC

19 :

.

- *ActiveDSO*
- *ScopeExplorer*

WavePro DSO

. *ActiveDSO*™ *ScopeExplorer*™ .
CD-ROM .

ActiveDSO

Microsoft ActiveX *ActiveDSO* Microsoft
Microsoft .
ActiveDSO *WavePro* DSO Visual C++, Visual
Basic ActiveX .
Microsoft Excel *WavePro* DSO
. *WavePro* DSO
.

ScopeExplorer

PC LeCroy Windows 95 Windows NT PC .
ScopeExplorer PC *WavePro* DSO
. *ScopeExplorer* LeCroy
ScopeExplorer .

ActiveDSO

ActiveDSO Microsoft .
Microsoft COM **ActiveX**
.

ActiveDSO
WavePro DSO . Visual C++, Visual Basic
Visual Basic for Applications (VBA)
. *ActiveDSO*
ActiveX .

ActiveX Visual Basic CreateObject
.
. ActiveDSO PC *WavePro* DSO
. .

10   VBA   Excel   *WavePro*
DSO   .
ActiveDSO   .

1.   *WavePro* DSO   OLE Automation compatible
      Client(PowerPoint)
                              .

2.   *WavePro* DSO   (VBA)
                                          VBA   .

            ActiveX   ActiveDSO
                                                          .

: **PowerPoint**

                                    Microsoft PowerPoint
                                          . *WavePro* DSO
| PowerPoint
| **:** | . |
| **PowerPoint 97** |
	1. CD-ROM ActiveDSO PC
·	.
	2. PC *WavePro* DSO
	.
·	3. PowerPoint .
	4. "Insert" **Object**
	.

5.   LeCroy ActiveDSO   .

6.   "Make Connection"   .

![wavepro logo]
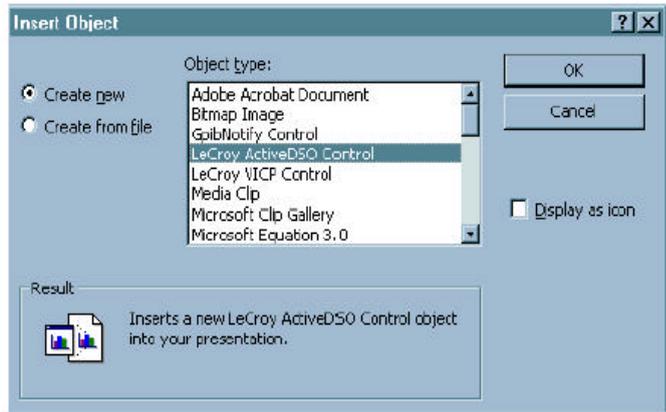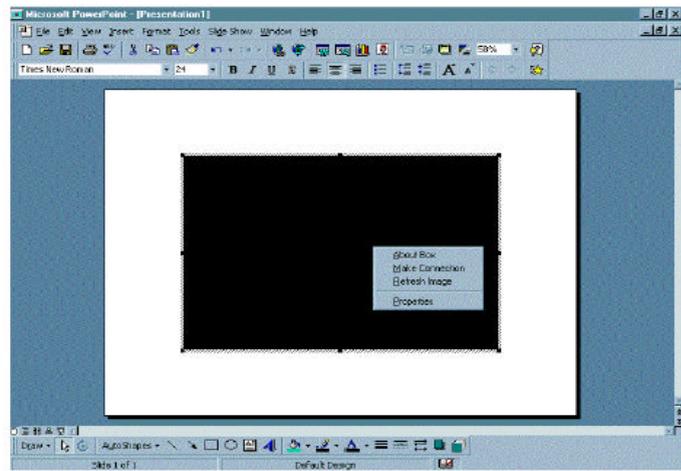
7.   "Network TCP/IP connection"   ("scope" = *WavePro* DSO).
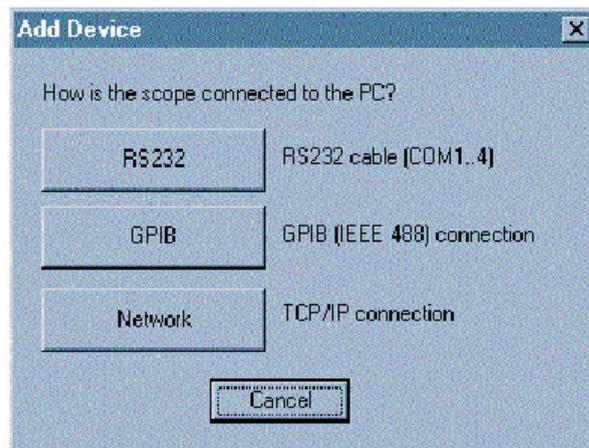
8.   *WavePro* DSO   IP   "OK"   .
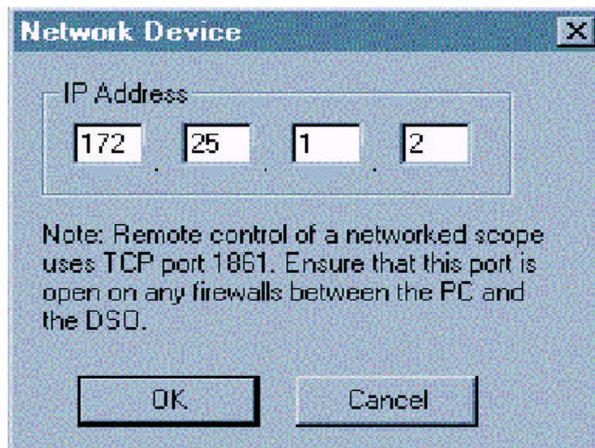
9. Refresh Image .
.
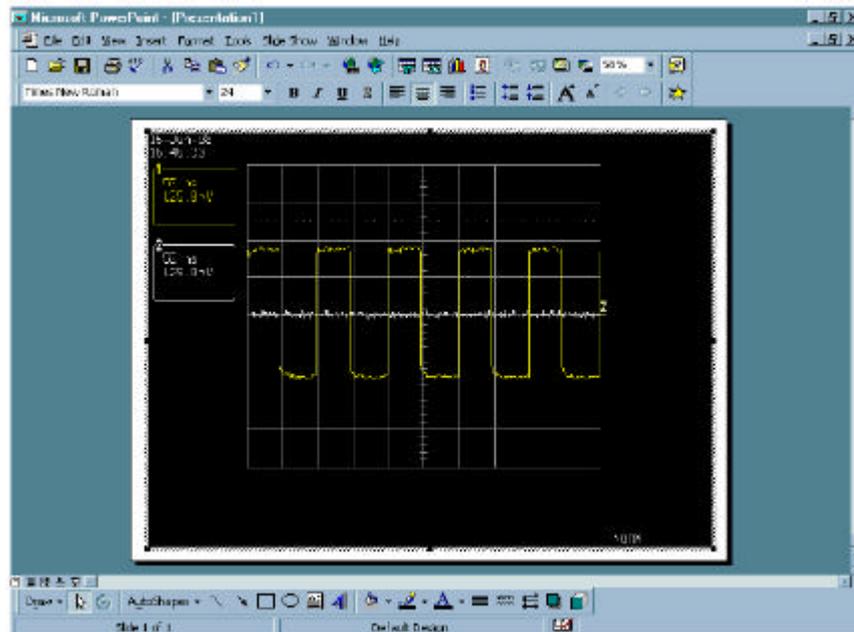
PowerPoint **WavePro DSO**

ActiveDSO™ WriteString()
DISP ON, C1:TRA ON, TRMD AUTO
( ). RefreshImage()
.

wavepro

: VBA

VBA   Windows   .   OLE
Automation Servers   ActiveX Controls   Visual
Basic   .   VBA Subroutine   *WavePro* DSO
                                    .

```
Sub LeCroyDSOTest()
Dim dso As Object

Set dso = CreateObject("LeCroy.ActiveDSO.1")

Call dso.AboutBox Present the control's About box
Call dso.MakeConnection("IP:172.25.1.2") Connect to the unit
Call dso.WriteString("DISP ON", 1) Enable the internal display
routine
Call dso.WriteString("TRMD AUTO", 1) Set the trigger mode to AUTO
End Sub
```

VBA   Microsoft Office   .
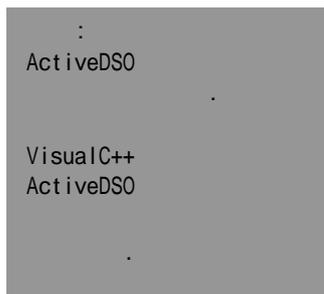
:	1. Tools Macro Visual Basic Editor
ActiveDSO	.
.	2. VBA Insert Module
	.
Visual C++	3 .
ActiveDSO	
	.
.	4. Subroutine .
	5. Run Run Sub/UserForm F5
	.

ScopeExplorer

1.　ScopeExplorer　　　　　.

2.　Scope　　Scope Finder　　　　　.

3.　　　　　　　　　"Scope Selector"　　　　"OK"　　　　　.

4.　ADD DEVICE　　　　　　"Network"　　　　　.（"Network"
　　 "ALT + N"　　　　　　　.）

5.　　　　　　　　　　　"Network Device"　　　　　.
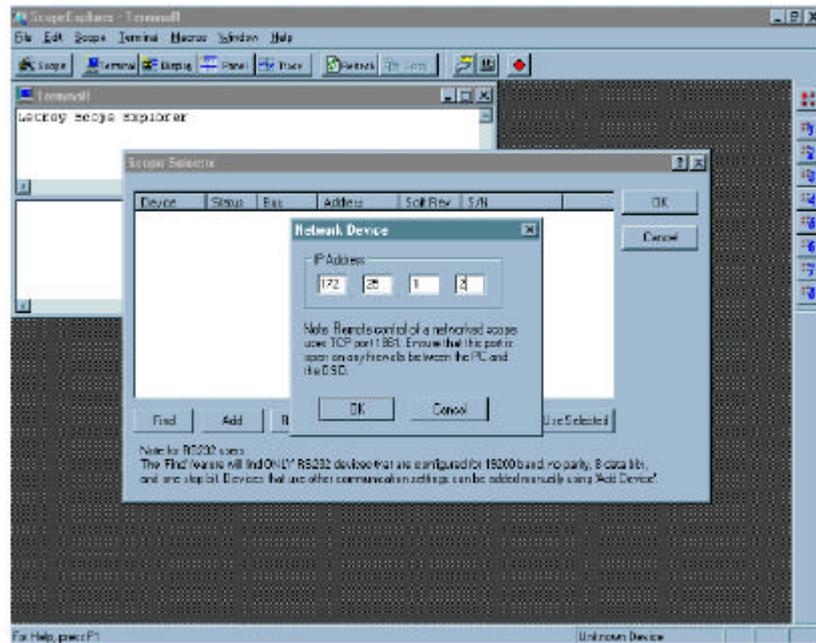
6.　"NETWORK DEVICE"　　WavePro DSO　 IP　　　　　　.

wavepro

ScopeExplorer   :

· *Terminal – Terminal*
            .

· *Image capture - Display   "   "*
                . Refresh   "   "   .

· *IP address change - ScopeExplorer   WavePro DSO   IP*
              .   2   .

ScopeExplorer   LeCroy   . LeCroy
www.lecroy.com   .

§ § §

(PROCESSORS)

WavePro DSO   (CPU)   PowerPX_microprocessor
.

. *WavePro* DSO

.

ADC

ADC   ,
,   .

(MEMORIES)

WavePro DSO

.

,   .

RIS

WavePro DSO   50GS/s   Random Interleaved Sampling (RIS)
.   20 ps   5 ps
.

(TRIGGER SYSTEM)

WavePro DSO
.   ,   (
)   .   AC, LF REJect, HF REJect, HF
DC   Positive   Negative   . *WavePro* DSO SMART
Trigger   .

(AUTOMATIC CALIBRATION)

WavePro DSO   .
(   )   .

.

wavepro

. 8   8
   .   . *WavePro* DSO
                  ,   . 10. 4
   TFT LCD   .

                                                                              .

Analog Persistence
                              . Full Screen
      .

                     PRINT SCREEN   .

WavePro DSO
                          .
         .
                                          .

(REMOTE CONTROL)

   WavePro DSO
                     .   GPIB (IEEE-488),   RS-232-C
LAN(   )   ,
                                                  . 12   " *WavePro* DSO
PC   "   .

H-Z, 50 W   +
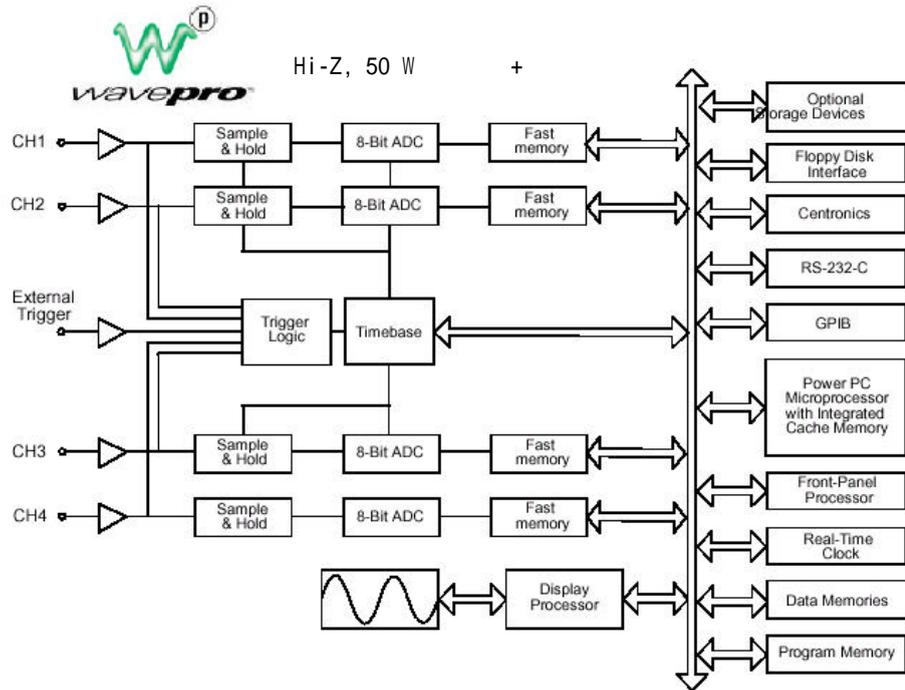
WAVEPRO 960, WAVEPRO 950, WAVEPRO 940

W *wavepro*

WavePro 960/950/940 4
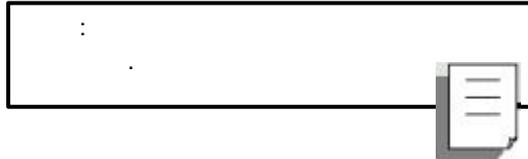
 Vertical

Bandwidth (-3dB): WavePro 960: 2 GHz * @ 50 Ω; **WavePro 950:** 1 GHz 50 Ω; **WavePro 940:** 500 MHz @50 Ω PP005 .

Bandwidth Limiter: 20 MHz 200 MHz.

Input Impedance: 50 Ω ±1.5%, 10 MΩ //11 pF typical (PP005)

Input Coupling: 1 MΩ: AC, DC, GND; 50 Ω: DC, GND

 Max Input: 50 Ω: 5 Vrms; 1 MΩ: 100 Vmax (AC 5kHz +DC)

Vertical Resolution: 8 . 11 (ERES)

Sensitivity: 50 Ω: 1 mV ~ 1 V/div ; 1 MΩ: 1 mV ~ 2 V/div

DC Accuracy: ±2.0%+1.5% Offset Value @ gain > 10 mV

Offset Accuracy: ±(1.5% + 0.5% + 1 mV)

Offset Range: 50 Ω 1 MΩ: 1 mV ~ 4.99 mV/div: ±400 mV 50 Ω: 5 mV ~ 99 mV/div: ±1 V, 0.1 V ~ 1 V/div: ±10V 1 MΩ: 5 mV ~ 100 mV/div: ±1 V, 101 mV ~ 2 V/div: ±20 V

Isolation – : V/div > 250:1

Timebase System

Timebase: 4

Time/Div Range: 200 ps/div ~ 1000 s/div

Clock Accuracy: 10 ppm

Interpolator Resolution: 5ps

External Clock Frequency: 500 MHz max., 50 W, 1 MΩ

&

Roll Mode – : time/div 500 ms ~ 1000 s/div   Sample Rate < 100 kS/s max.

*. > 4 GS/s   @ 10 mV /

External Reference(Optional): 10 MHz

External Timebase Clock: EXT BNC   500 MHz

Acquisition System

	Single Shot Sample Rate		
	WavePro 960	WavePro 950	WavePro 940
1 Channel Max	16 GS/s	16 GS/s	8 GS/s
2 Channel Max	8 GS/s	8 GS/s	8 GS/s
3 4 Channel Max	4 GS/s	4 GS/s	4 GS/s

	Max. Acquisition Points/Channel 1 Ch / 2 Ch / 3-4 Ch		
	WavePro 960	WavePro 950	WavePro 940
Standard	1M/500k/250k	1M/500k/250k	1M/500k/250k
M Memory Option	4M/2M/1M	4M/2M/1M	4M/2M/1M
L Memory Option	16M/8M/4M	16M/8M/4M	16M/8M/4M
VL Memory Option	32M/16M/8M	32M/16M/8M	32M/16M/8M
XL Memory Option	64M/32M/16M	—	—

	Acquisition Modes		
	WavePro 960	WavePro 950	WavePro 940
Random Interleaved Sampling (RIS)	50 GS/s for repetitive signals: 200 ps/div ~ 1µs/div		
Single Shot	For transient and repetitive signals : 200 ps/div ~ 1000 s/div		
Sequence	2 ~ 8000 segments		
Max. segments/memory	8000/16M 1000/1M 250/250K		
Intersegment Time	Typically 30 µs		

Acquisition Processing: Averaging: 10^3 .
10^6 . 1: 1
1: 1023

Enhanced Resolution (ERES): 8.5 11

Envelope (Extrema): 10^6 Envelope, ,

Triggering System

Modes: NORMAL, AUTO, SINGLE STOP

Sources: , External, EXT/5 Line; ,

Slope: Negative, Positive, Window

Coupling Modes: DC, AC, HF, HFREJ, LFREJ

    AC Cutoff Frequency: 7.5 Hz

    HFREJ, LFREJ: 50 Hz

    Pre-trigger Recording: 1 ~ 100%

    Post-trigger Delay: 0 ~ 10,000

    Holdoff by Time or Events: 20s 1 ~ 99,999,999

    Internal Trigger Range: ±5 div

Maximum Trigger Frequency: Bandwidth (HF) 500 MHz (AC, DC)

⚠ **External Trigger Input Range** ±0.5 V (Ext/5 ±2.5 V)

Max. External Input @ 50 Ω: ±5 V DC   5 V rms

Max. External Input @ 1 MΩ: 100 V max. (DC +   AC < 5 kHz)

SMART Triggers(   )

Edge/Slope/Window/Line: . Window

.

.

0.5ns   .

State or Edge qualified:

.

.

Dropout: 2ns   20ns   .

Pattern 5   (4   )   :   high, low
don't care   .   .

SMART Triggers with Exclusion Technology

Signal or Pattern Width: 600ps   20s

.

Signal or Pattern Interval: 2ns   20s   .

Slew Rate: . dV/dt   .

Runt: Positive   Negative runt   600ps 20ns

.

AutoSetup

,   .

Vertical Find

.

Probes

Model PP005: 10:1, 10MΩ   ,

ProBus Probe System   ,   ,   ,

.

Scale Factors: 12   .

W wavepro

Color Waveform Display

Type: 10.4 TFT LCD

Resolution: 640 x 480

Screen Saver: 10 .

Real Time Clock: , ,

Number of Traces: , , Math 8

Grid Styles: Single, Dual, Quad, Octal, XY, Single+XY, Dual+XY; Full Screen
.

Intensity Controls: .

Waveform Display Styles: –
.

Trace Overlap Display:

Analog Persistence Display

Analog Persistence and Color Graded Persistence: :

Trace Selection , 2 Analog
Persistence

Persistence Aging Time: 500

Trace Display:

Sweeps displayed

Zoom Expansion Traces

Display up to four zoom traces

    Vertical Zoom 5 . 50

    Horizontal Zoom 2 pts/div . 50 000

    Auto Scroll: Math

Rapid Signal Processing

Processor: PowerPC

Processing Memory: 256 Mbytes

Real-time Clock: , , , 1 ns

Pass/Fail: 5   .
                    PC   .
        ,   , GPIB SRQ
                                                                .

Internal Waveform Memory

Waveform M, M2, M3, M4 (16   /   )

Zoom and Math   A, B, C, D

Setup Storage

Front Panel and Instrument Status: 4
                                                              .

CUSTOM DSO   (VDisk)   6   Custom DSO
                                                      .

Remote Control: GPIB,   RS-232-C

RS-232-C: 115.2 kbaud*

GPIB Port: Talker/Listener   IEEE-488.2

Ethernet(optional): 10BaseT Ethernet   *

Floppy Drive: , DOS   , 3.5   ,

PC Card Slot:

External Monitor Port: 15   D   VGA   *

Centronics Port: *

Internal graphics printer(optional): 10s
10   GPR10   .

Pass/Fail and Trigger Output: Cal BNC   Cal Signal, Pass/Fail Condition,
Trigger Ready   Trigger Out   .

⚠

                                                                          .

Calibrator Signal: 500 Hz ~ 2 MHz   25 ns   :   BNC   1
MΩ   0.05 ~ +1.0V

Control Signals: Trigger Ready, Trigger Out   Pass/Fail

Math

4   Math   .   Math
Math   .   :   ,   ,   ,   ,   ,   ,
    , 1000   ,   , 11   ERES
                        , 50 kpoint   FFT, Envelope   Extrema,
                ,   (   ), sin x/x,   (   ),   ,
        ,   , (e   10),   ,   ,   , 200
                        ;   .

              :

· **Relative Time:**   ±0.05%

_____._____

*. CE   (EMC Directive 89/336/EEC)

· **Relative Amplitude(Voltage):**   ±0.2%
                        .

· **Absolute Time:**
            .

· **Absolute Amplitude(Voltage):**   .

Automated Measurements: ,   ,
                .

Pass/Fail: 5   .
                    PC   .
        ,   , GPIB SRQ
                              .

WAVA (WaveAnalyzer)

1 Mpoint   ,   ,   , 1   , 20
                                    18   FFT   Math
                .

WAVAPRO (WaveAnalyzer Pro)

WAVA   .

&

JTA (Jitter and Timing Analysis):   ,   ,

   .

DFP (Digital Filter Package): 8   Finite Impulse Response (FIR)
             . CustomFilters   .
                      .

Auto Calibration   DC   1   .

Auto Calibration Time: < 500 ms

Power Requirements: : < 350 VA

Voltage	
90 ~ 132 V AC	45 ~ 440HZ
180 ~ 250 V AC	45 ~ 66HZ

Battery Backup   2   .

Dimensions(HWD): 264mm x 397mm x 453mm (10.4 in. x 15.6 in. x 17.8 in.);

Weight: 14kg (31 lbs)

Shipping: 22.2 kg (49 lbs)

Warranty and Calibration: 2 .   .

   Temperature: 5 ~ 40°C,   0 ~ 45°C,   −20 ~ 60°C

   Humidity: 25   75% RH(   ). 45   50% RH

   Altitude: 25   3,000m. 45   2,000m   4500 m

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Certifications: CE, UL cUL

CE EMC Directive 89/336/EEC for Electromagnetic
Compatibility and Low Voltage Directive 73/23/EEC for Product Safety
.

EMC Directive: EN 61326-1: 1997 +A1: 1998

, EMC

: EN55022: 1998, Class A

EN 61000-3-2: 1995+A1: 1998+A2: 1998

EN 61000-3-3: 1995

: **Class A** .

.

: EN 61000-4-2: 1995 +A1: 1998*

EN 61000-4-3: 1996 +A1: 1998* RF

EN 61000-4-4: 1995* /

EN 61000-5-4: 1995*

EN 61000-6-4: 1996* RF

EN 61000-4-11: 1994**

* Performance Criteria "B" . ,
.

** Performance Criteria "C" . ,
.

Low Voltage Directive: EN 61010-1: 1993 +A2: 1995

,

EN 61010-1   .

300 V Installation (Overvoltage) Category II

2

1

UL   cUL   UL Standard: UL 3111-1

Canadian Standard: CSA-C22.2 No. 1010.1-92.

:

B/W   LaserJet, DeskJet, Epson

Color: DeskJet 550C, Epson Stylus, Canon 200/600/800

.

200 cm/div

Hard
Copy
Formats: TIFF   , TIFF   , BMP   BMP

§ § §

Acquisition Time:

ACSN

ADC: -

Aliasing:
. "   "   ,
.

AND   TRUE   TRUE

Aperture Jitter: -   ADC   (   )
.   .
t*dV/dt   .   t
dV/dt   . "   " "
"   .

Aperture Uncertainty: ,   (ADC   ),
-     ADC   (   )
. "   "
"   "   .

Area: DSO
.

Artifact Rejection
.

Automatic Setup ,
.

Average: ,   .

AWG

Bandwidth 3 dB
.

BER .

Binning .

wavepro

Bit: "   "   0   1   .
                                    .

Bit Error Rate:

CCD   .   ,
                        .

CCTM   (Clock Certification test module)

Channel: (   )
              .

Clamping   , FET,   ,
                                        (   )   .

Coherent Gain
1.0(0 dB)   1.0   .
                          .

Common Mode Range: (   ).

Common Mode Rejection Ratio   . dB   .
                                                  .

Common Mode Signal (Noise):
                  (   ).   .

Continuous Averaging: "   "
                                              .
                                    . S(i,new) = N/(N+1) * [S(i,old) + 1/(N+1) * W(i)].
              i =   ; W(i) =   ; S(i,old) =
        ; S(i,new) =   ; N =   (1,3,7...).

Conversion Cycle: .
                                ,   BCD   .

Crosstalk:

Cursor:
      . LeCroy DSO
"   "   .

DAC: -

Data Logger: ( )
.   .

DC: .   .

DC Level Shift: DC

DC Offset: DC .
.

DC Overload
.

Dead Time:
.

Decimation: n
.   n   .

Differential Input: .

Differential Linearity: .

Differential Non Linearity: 1.
. 2 ( ) ADC
TDC .
.

Differential Output:
.

Differential Pulses: .

Dithering: ADC (
) .
ADC .
.

Digital Filtering:
.

Dropout Trigger: (
LeCroy DSO 25ns 20s) . ,
,
.

![wavepro logo]

Duty Cycle:

.

Dynamic Range:

.

Dynamic RAM(DRAM):

ECL: . , . ECL
LOGICAL 1 = -1.6 V LOGICAL 0 = -0.8 V.

ENI: .

ENBW(Equivalent Noise Bandwidth): ENBW
( )

.

Enhanced Resolution(ERES): LeCroy
DSO .

. ERES Signal Averaging

.

Envelope: . LeCroy DSO
1 10^6 .

EPROM . 0 1

.

Equivalent Time Sampling(ETS): (ETS).

. .

Extrema ( )
( ) Envelope .

.

.

Fall time 90% 10%
. .

Fast Fourier Transform(FFT): FFT n
n Fouries
. " " (0) n/2

.

Feedthrough: .

FFT: Fourier   .

FFT Frequency Bins: Fourier   (FFT)   n/2
              n/2   .
                                                              n/2 "   "   .
                          Hz   .   f = 1/T.
T   .   f   .

FFT Frequency Range: FFT   0 Hz   Nyquist
              .

FFT Frequency Resolution: f   .   ,
                      f   f   .
                                                                      .   (,
)   .
                                      ENBW   f   (,   ).

FFT Number of Points: FFT   (   )
        . FFT   n/2   .

FFT Total Power: -

FIFO: (   ).

Filter:

                                                                      .
                              ,   (kc/s)
                                                                          ,
              .

Flash ADC: 2n-1
                                                              -              .   n   ADC
              .   .

Floor: Envelope   (   )   .

FWHM: Full-Width Half Maximum   50%
              .

Gate: 1.   (AND, OR)   2
                                                          .

Glitch:

.

.

Glitch Trigger: .

Ground Loop: ,

.

HF Sync:

.

Histogram .

.

Holdoff by Events: .

.

. Holdoff

.

Holdoff by Time: .

.

.

HPGL: Hewlett-Packard Graphics Language Format; Hewlett-Packard Company.

Hybrid Circuit: ,

.

IC: . ,

.

Integral Linearity: .

Integral Non Linearity: ADC .

. ADC +

.

Interleaved Clocking:

.

.

Interval Trigger: .

(Positive)

.

.

jitter: .

Leakage: Power Spectrum

.

Limiter: (,).

Logical 1: TRUE (,).

Logical 0: FALSE (,).

Long Term Stability: .

MOA: ( ).

Mean Value: DC .

Median Value: .

Mode Value: .

Monolithic IC: (, , ,) .

Monotonic: .

Multiplexer: .

NAND (Negative) AND .

Negation: Negative Positive , Positive Negative

NLTS: . (Non-linear transition shift)

Noise Equivalent Power: NEP(W): RMS RMS .

NOR (Negative) OR .

NRZ: . (non-return to zero)

wavepro

Nyquist Frequency: Nyquist (f/2) (f)
. , (f)
" " f/2
.

Offset: (0)
.

OR .

Overshoot, Negative:
.

Overshoot Positive:
.
.

Paralled Converter: 2n-1 -
. n ADC .

Pass/Fail Testing:
.

PCMCIA: PC Personal Computer Memory Card Industry Association .
JEIDA .

PCX PC Paintbrush Format. ZSoft Corporation, Marietta, GA

Peak Spectral Amplitude: .

Period 50% (mesial)

Persistence:
DSO .

PES: .

PHA (Pulse Height Analyzer): .

Picket Fence Effect: FFT
Power Spectrum
. .
3.92 dB
(1.57). Picket Fence Effect(Scallop
Loss) . Flat

Top   .

Power Spectrum   (V^2). Power Spectrum dBm   0
dBm V^2_{ref} = (0.316 V peak)$_2$. V_{ref} 50( )   1 mW
                                            .

Power Density Spectrum Power Spectrum   Hz   (V $_2$
/Hz)   . Power Density Spectrum dBm   , 0 dBm (V $_2$ $_{ref}$
/Hz)   .

Pre-trigger Sampling:
                          .

PRML: .

Pulse Width   Pulse Start(mesial   . ,
        50%)   Pulse Stop(mesial   )   .

Pulse Start: 50%   (mesial   ).

Pulse Stop: 50%   (mesial   ).

Pulse Start: .
                          .
                          .

RAM   .

Random Interleaved Sampling(RIS): EQT(ETS)   .
        DSO
          .
                  . EQT   RIS   "Free"   .

Real Time: .

                          .

Reciprocal:

Reflection Coefficient: ,
          .

Resolution ADC   1   .

Reverse Termination
          .

RF (Radio Frequency): .

RFI (Radio Frequency Interference):
EMI .

Risetime: 10% 90%
. .

RMS (Root Mean Square):
.

.

.

ROM .
. .

Roof: Envelope ( ) .

SAM (sequenced amplitude margin).

Sample and Hold .

Sampling Frequency: DSO
.

Scallop loss: .

SECAM .

Sensitivity: 1. . **2.**
(ADC counts/mV
). .

Shot Noise:
. (Watts) (Amps)
.

SMART Trigger: SMART Trigger .
,
.
.

Smoothing, N point: "N"
.

SNR Signal-to-Noise Ratio .

Square: .

Stage Delay: ( )
.

Standard Deviation: .
.

Standard Trigger:
. , , .
WavePro DSO .

State Qualified:
. AND .
.
.

Stop Trigger: .
, :
.

TAA: .

TDC: -

Terminate:
.

Test Template: ( )
.

TFT:

Threshold: .
.

TIE: .

TIFF (Tagged Image File Format): .

Time Between Patterns:
.
.

Timeout:
.

.

Time Qualified

.

.

Tolerance Mask:
.

Track and Hold:

-                                    .

ADC   .

Transient Recorder: .

TTL (Transistor-Transistor Logic):   . LOGICAL 0 = 0 ~
0.8 V   LOGICAL 1 = 2.0 ~ 5.0 V.

Trend: .

VIS: Viterbi

Waveform Digitizer:

.

Window Function Fourier   .
Fourier   (   )   . LeCroy

.   [W= … a m cos(2¼k/N)].   N
k   .

XY Display: .

.   Lissajous
.

§ § §

Numerics