'pst-osci'*
A PSTricks package for oscilloscopes

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Abstract: **'pst-osci'** is a PSTricks package to draw easily oscilloscope screen shots. Three channels can be used to represent the most common signals (damped or not): namely sinusoidal ($y = A\exp(-\lambda t)\sin(\frac{2\pi}{T}t + m\cdot\sin(\frac{2\pi}{T_m}t)+\varphi)+c$), rectangular, triangular, dog's tooth (left and right oriented). The third channel allows you to add, to subtract or to multiply the two other signals. Lissajous diagrams (XY-mode) can also be obtained.

Contents

1 Introduction

'pst-osci' offers a unique macro with few parameters to interact on it (it is the same approach as in Denis Girou's **'pst-poly'** package).

The syntax is simply: `\Oscillo[optional parameters]`.

As for a real oscilloscope, it is important to choose the correct sensivity for each channel in relation to the amplitude of the signal. If you did the wrong choice, you will get bad-looking curves.

The style of the curves can be customized using the standard PSTricks parameters.

2 Usage

2.1 Parameters

There are thirty specific parameters defined to change the way the screen shots are drawn.

Henceforth, the signals represented on channels A, B and C will be called 'SignalA', 'SignalB' and 'SignalC'.

period1 (real): period T_1 (in ms) of SignalA (*default: 20*).

period2 (real): period T_2 (in ms) of SignalB (*default: 20*).

amplitude1 (real): amplitude A_1 (in V) of SignalA (*default: 2*).

amplitude2 (real): amplitude A_2 (in V) of SignalB (*default: 0 – no signal*).

periodmodulation1 (real): period T_{m1} (in ms) of SignalA (*default: 100*).

periodmodulation2 (real): period T_{m2} (in ms) of SignalB (*default: 100*).

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*Thanks to Denis Girou for his most valuable help and his encouragements.

`freqmod1` **(real):** modulation factor m_1 of SignalA (*default: 0*).

`freqmod2` **(real):** modulation factor m_2 of SignalB (*default: 0*).

`phase1` **(real):** phase φ_1 (in deg) of SignalA (*default: 0*).

`phase2` **(real):** phase φ_2 (in deg) of SignalB (*default: 0*).

`CC1` **(real):** continuous component c_1 (in V) of SignalA (*default: 0*).

`CC2` **(real):** continuous component c_2 (in V) of SignalB (*default: 0*).

`damping1` **(real):** damping λ_1 of SignalA (*default: 0 – no damping*).

`damping2` **(real):** damping λ_2 of SignalB (*default: 0 – no damping*).

`wave1`: type of the SignalA chosen between `\SinusA`, `\RectangleA`, `\TriangleA`, `\LDogToothA`, `\RDogToothA` (*default: \SinusA*).

`wave2`: type of the SignalB chosen between `\SinusB`, `\RectangleB`, `\TriangleB`, `\LDogToothB`, `\RDogToothB` (*default: \SinusB*).

`timediv` **(real):** scale (in ms) of the time axis (*default: 5*).

`Lissajous` **(boolean):** switch to XY-mode (true) or not (false) (*default: false*).

`sensivity1` **(real):** scale (in V) of the channel A vertical axis (*default: 1*).

`sensivity2` **(real):** scale (in V) of the channel B vertical axis (*default: 1*).

`plotstyle1`: determines what kind of plot you will get for channel A (*default: GreenContA*). Note that you can customize the plotstyle using the `\newpsstyle` macro (see below for examples).

`plotstyle2`: determines what kind of plot you will get for channel B (*default: BlueContB*). Same remark as above.

`plotstyle3`: determines what kind of plot you will get for XY-mode (*default: RedContLissajous*). Same remark as above.

`plotstyle4`: determines what kind of plot you will get for add, sub or mul operation (third channel) (*default: MagentaContAddSub*). Same remark as above.

`combine` **(boolean):** if true allows to draw combination of SignalA and SignalB on channel C (namely addition, subtraction or multiplication) (*default: false – no signal*). See next item.

`operation`: determines what kind of operation will be applied to SignalA and SignalB to get SignalC. The valid parameters are add, sub and mul (*default: \relax – no operation*).

`Fourier` **(integer):** see below (Section 2.2) (*default: 100*).

`offset1` **(real):** offset c_1' (in V) of SignalA (*default: 0*).

`offset2` **(real):** offset c_2' (in V) of SignalB (*default: 0*).

`offset3` **(real):** offset c_2' (in V) of SignalC (*default: 0*).

2.2   Rectangular, triangular and dog's tooth signals

The parameter `Fourier` controls the precision of the Fourier transform used to draw rectangular, triangular and dog's tooth signals. The number of terms is fixed to 100 by default in order to minimize the computation time. But you can give `Fourier` any value you want.

Note that those signals can also be damped using the `damping1` and `damping2` parameters. By default, there is no damping ($\lambda = 1$).

2.3   'pst-osci' and LaTeX

'pst-osci' defines colors that may interact with the **'color'** package. You should then use the **'pst-col'** package and load **'pst-osci'** this way:

```
\usepackage{pstcol,pst-osci}
```

2.4   Reducing the size of the Oscilloscope

The oscilloscope is put inside a 10 cm square `pspicture` environment. There are two ways to reduce the size of the box, depending on the fonts you use.

2.4.1   Using PostScript fonts

We recommend that solution because it allows you to treat fonts like any other PostScript object. As a matter of fact, you can, for instance, put your `\Oscillo` macro inside a PSTricks `\psscalebox`. It is very simple and offers good results. However, pay attention to the fact that, if you are using non-PS fonts, the result will look ugly!

2.4.2   Using non-PostScript fonts

If you use non-PS fonts and if you want to reduce the size of the Oscilloscope, you should type something like:

```
{\psset{unit=0.5}\footnotesize\Oscillo}
```

3   Examples

3.1   Basic examples

──────── The \Oscillo macro, default parameters ────────

```
\psscalebox{0.5}{\Oscillo}
```
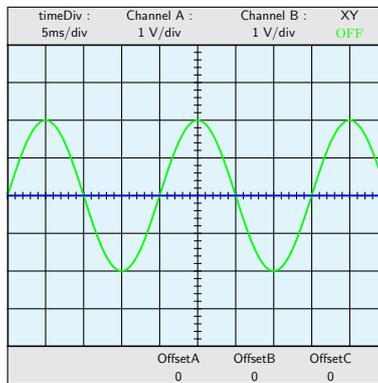

In order to minimize the size of the file, all the oscilloscopes are drawn scaled $\frac{1}{2}$. This reduced scale is not represented.

If you only want to see SignalA then set `offset2` in order to have `offset2` $\in]-\infty, -4 \times$ `sensivity2`$[\cup]4 \times$ `sensivity2`$, +\infty[$:


3
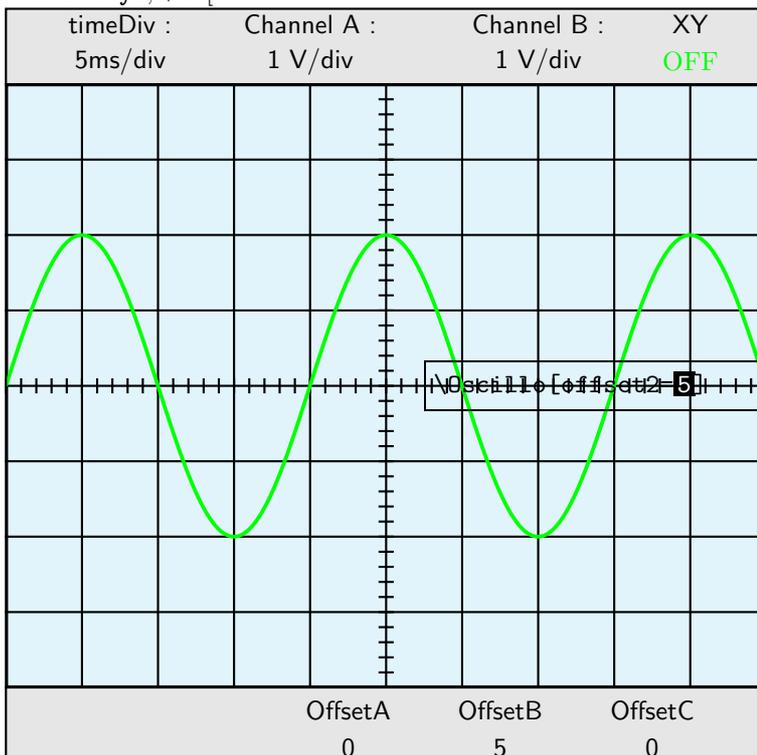
Let's have a look at Channel A:

```
─── The importance of sensivity ───
% Extrema invisible
\psscalebox{0.5}{\Oscillo[offset2=5,amplitude1=5]}
% Good sensivity choice
\hfill
\psscalebox{0.5}{\Oscillo[offset2=5,amplitude1=5,sensivity1=2]}
```
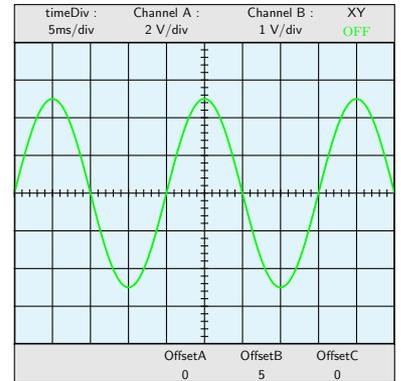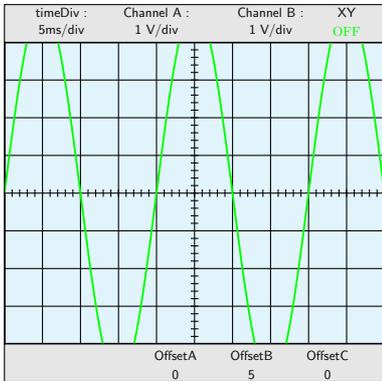

Now, let's have two signals on Channel A and B. By default, the two signals have the same period and the same phase:

```
% Different amplitude
\psscalebox{0.5}{\Oscillo[amplitude1=3,amplitude2=1.5]}
% Different period
\hfill
\psscalebox{0.5}{\Oscillo[amplitude1=3,amplitude2=1.5,period2=50]}
% Different phase
\hfill
\psscalebox{0.5}{\Oscillo[amplitude1=3,amplitude2=1.5,phase1=60,phase2=-30]}
```
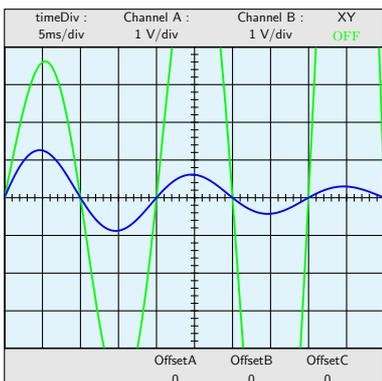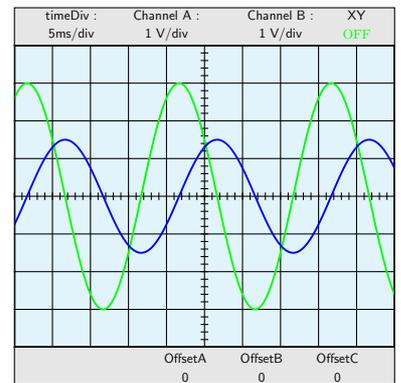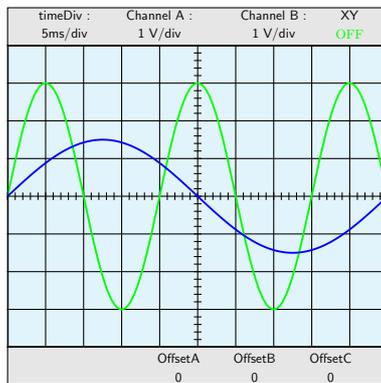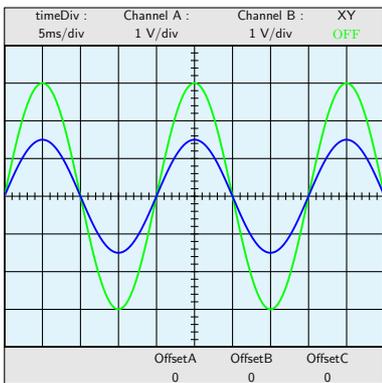


```
─── Damping and amplification ───
\psscalebox{0.5}{\Oscillo[amplitude1=3,amplitude2=1.5,
   damping2=0.005,damping1=-0.005]}
```
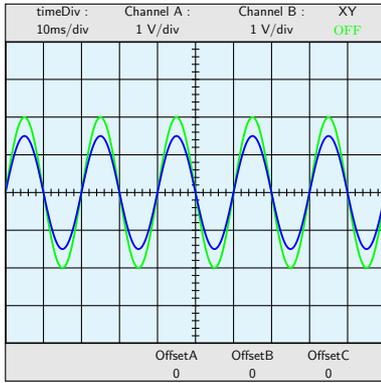
─── Changing the time scale ───
```
\psscalebox{0.5}{\Oscillo[amplitude2=1.5,timediv=10]}
```
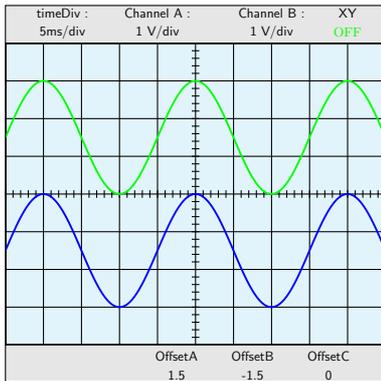

─── Vertical translations ───
```
\psscalebox{0.5}{\Oscillo[amplitude1=1.5,amplitude2=1.5,
    offset1=1.5,offset2=-1.5]}
```

─── Changing the plot style ───
```
\newpsstyle{BlueDots}{plotstyle=dots,
  linecolor=blue,linewidth=0.02,plotpoints=50}
\psscalebox{0.5}{\Oscillo[amplitude1=3,plotstyle2=BlueDots,amplitude2=2]}
\newpsstyle{GreenDash}{linestyle=dashed,
  linecolor=green,linewidth=0.035,plotpoints=50}
\hfill
\psscalebox{0.5}{\Oscillo[amplitude1=2,phase1=90,amplitude2=3.8,period1=25,
  period2=50,phase2=10,plotstyle1=GreenDash]}
```
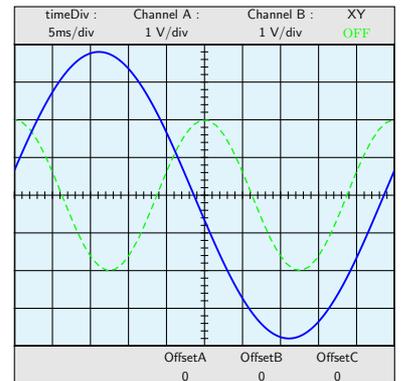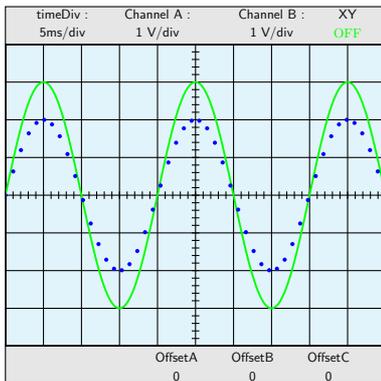

3.2 Channel C: operations

Note that offset1 and offset2 are **not** taken into account in the operations when the combine parameter is set to true.

─── Additions ───
```
\psscalebox{0.5}{\Oscillo[amplitude2=1.5,period2=50,period1=10,
  combine=true,operation=add]}
\hfill
\psscalebox{0.5}{\Oscillo[amplitude2=1.5,period2=50,period1=10,
  combine=true,operation=add,offset1=2,offset2=2]}
\hfill
% SignalA and SignalB are invisible
\psscalebox{0.5}{\Oscillo[amplitude2=1.5,period2=50,period1=10,
  combine=true,operation=add,offset1=6,offset2=6]}
```

| timeDiv :	Channel A :	Channel B :	XY
5ms/div	1 V/div	1 V/div	OFF

add:	OffsetA	OffsetB	OffsetC
ON	0	0	0

timeDiv :	Channel A :	Channel B :	XY
5ms/div	1 V/div	1 V/div	OFF

add:	OffsetA	OffsetB	OffsetC
ON	2	2	0

timeDiv :	Channel A :	Channel B :	XY
5ms/div	1 V/div	1 V/div	OFF

add:	OffsetA	OffsetB	OffsetC
ON	6	6	0

timeDiv :	Channel A :	Channel B :	XY
5ms/div	1 V/div	1 V/div	OFF

sub:	OffsetA	OffsetB	OffsetC
ON	0	0	0
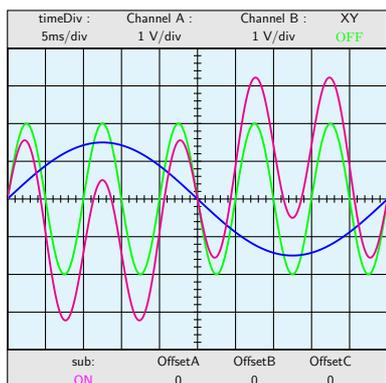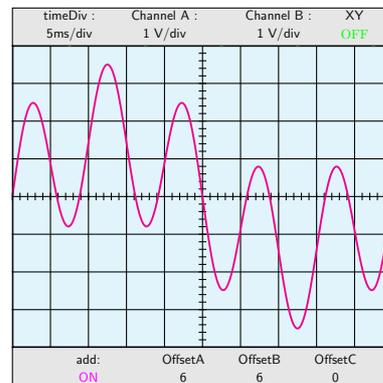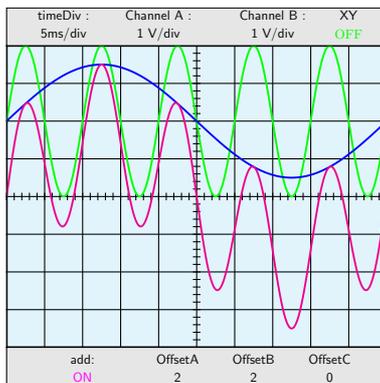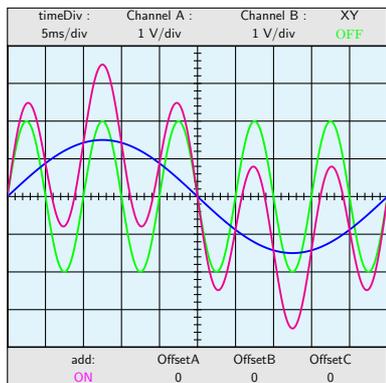
─── Subtraction ───

```
\psscalebox{0.5}{\Oscillo[amplitude2=1.5,period2=50,period1=10,
  combine=true,
  operation=sub]}
```

─── Multiplications ───

```
\psscalebox{0.5}{\Oscillo[amplitude2=1.5,period2=50,period1=10,
  combine=true, operation=mul]}
\hfill
\psscalebox{0.5}{\Oscillo[amplitude1=1,amplitude2=2,
  period2=50,period1=2,combine=true, operation=mul]}
```

timeDiv :	Channel A :	Channel B :	XY
5ms/div	1 V/div	1 V/div	OFF

mul:	OffsetA	OffsetB	OffsetC
ON	0	0	0

timeDiv :	Channel A :	Channel B :	XY
5ms/div	1 V/div	1 V/div	OFF

mul:	OffsetA	OffsetB	OffsetC
ON	0	0	0

3.3   Channel C: XY-mode

timeDiv :	Channel A :	Channel B :	XY
5ms/div	1 V/div	1 V/div	ON

|	OffsetA	OffsetB	OffsetC
	0	0	0
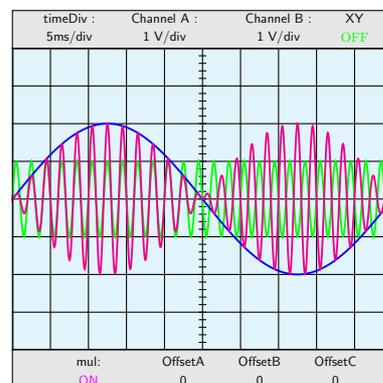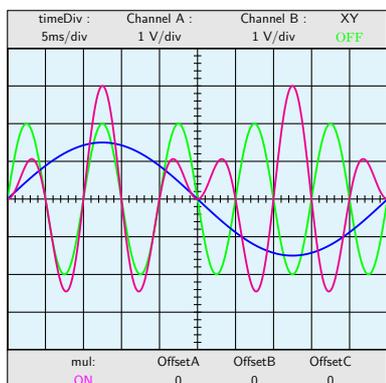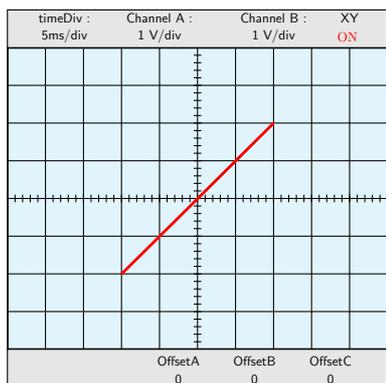
─── Basic Lɪssᴀᴊᴏᴜs curve ───

```
\psscalebox{0.5}{\Oscillo[Lissajous=true,amplitude2=2]}
```

```
\psscalebox{0.5}{\Oscillo[Lissajous=true,amplitude2=3,phase2=45]}
\hfill
\psscalebox{0.5}{\Oscillo[Lissajous=true,amplitude2=2,phase2=90]}
```
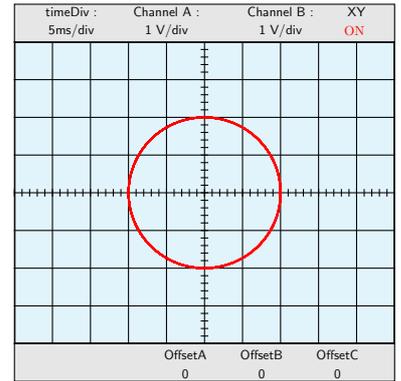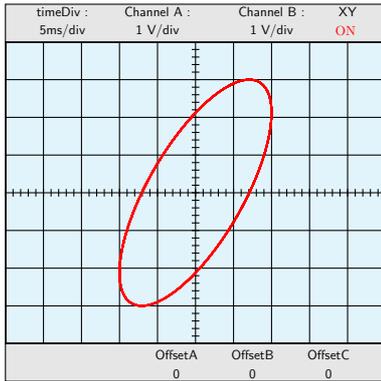
```
\psscalebox{0.5}{\Oscillo[amplitude1=3.5,phase1=90,amplitude2=3.5,
  period1=20,period2=10,phase2=0,Lissajous=true]}
\hfill
\psscalebox{0.5}{\Oscillo[amplitude1=3.5,phase1=90,amplitude2=3.5,
  period1=25,period2=5,phase2=60,Lissajous=true]}
```
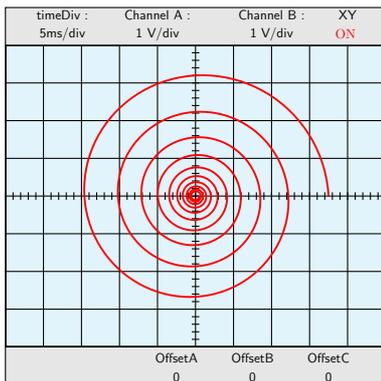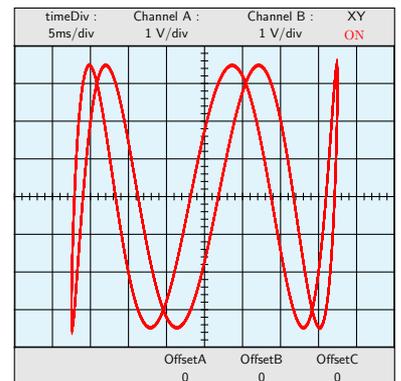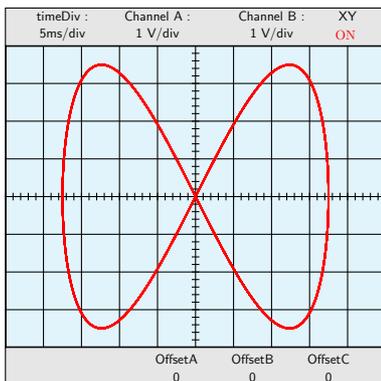
A damped Lissajous diagram
```
\psscalebox{0.5}{\Oscillo[amplitude1=3.5,phase1=90,
  amplitude2=3.5,period1=50,period2=50,
  Lissajous=true,damping1=0.01,damping2=0.01]}
```

3.4   Non sinusoidal signals

Exponential signals
```
 \psscalebox{0.5}{\Oscillo[amplitude1=3.5,phase1=90,
  period1=2E30,offset2=5,damping1=0.02]}
\hfill
 \psscalebox{0.5}{\Oscillo[amplitude1=3.5,phase1=90,
  period1=2E30,offset2=3,amplitude2=-3,damping1=0.02,
  period2=2E31,damping2=0.02,phase2=90]}
```
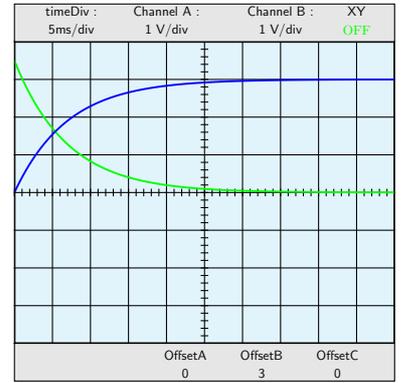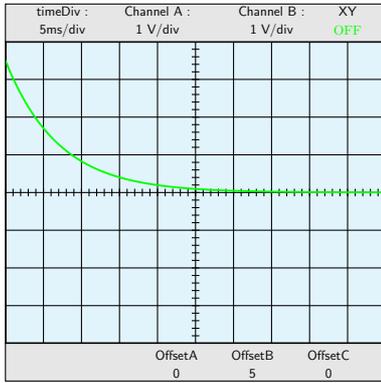
Note: the maximum value for `period1` and `period2` is ±2E31.

─── Non-sinusoidal signals ───
```
 \psscalebox{0.5}{\Oscillo[Wave1=\TriangleA,amplitude2=2,period2=20,period1=25]}
\hfill
 \psscalebox{0.5}{\Oscillo[Wave1=\RectangleA,amplitude2=2,period2=20,period1=25]}
```
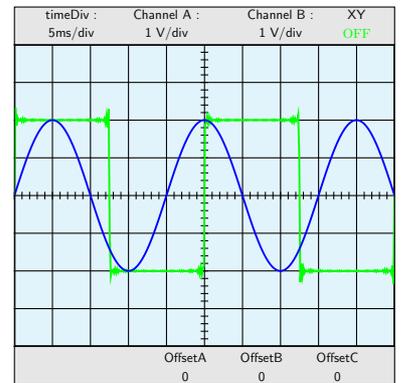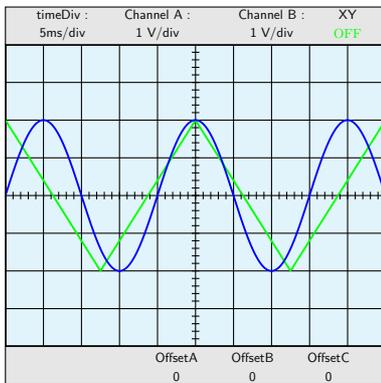

─── Combine examples ───
```
 \psscalebox{0.5}{\Oscillo[Wave2=\TriangleB,combine=true,operation=mul,amplitude2=2,
  period2=50,period1=2,amplitude1=1]}
\hfill
 \psscalebox{0.5}{\Oscillo[combine=true,operation=add,amplitude2=1.5,
  Wave1=\RectangleA,amplitude1=1.5,period2=15]}
\hfill
 \psscalebox{0.5}{\Oscillo[combine=true,operation=add,amplitude2=1.5,
  Wave1=\RectangleA,amplitude1=1.5,period2=15,Wave2=\TriangleB]}
```
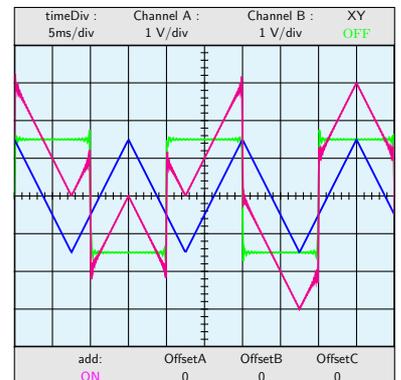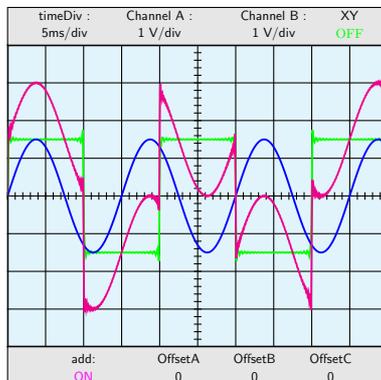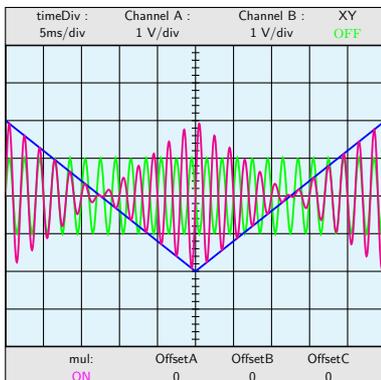

─── Dog's tooth signal ───
```
 \psscalebox{0.5}{\Oscillo[combine=true,operation=mul,amplitude2=1.5,
 Wave1=\RDogToothA,amplitude1=1.5,period2=15]}
\hfill
 \psscalebox{0.5}{\Oscillo[amplitude1=3.5,phase1=90,amplitude2=3.5,
  period1=25,period2=6.25,phase2=0,Lissajous=true,Wave2=\RDogToothB]}
```
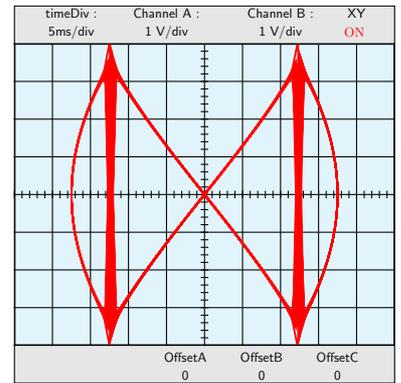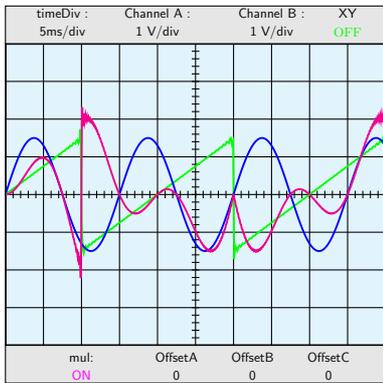
## 3.5   Frequency modulation examples
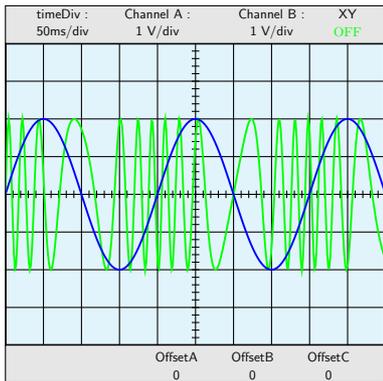
```
\psscalebox{0.5}{\Oscillo[periodmodulation1=200,freqmod1=5,
 period1=30,
 timediv=50,plotpoints=1000,amplitude2=2,period2=200]}
```
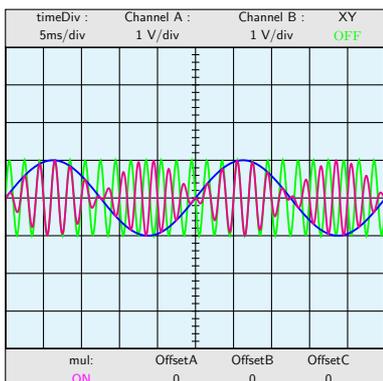
```
\psscalebox{0.5}{\Oscillo[amplitude1=1,amplitude2=1,
 period2=25,period1=2,combine=true,operation=mul]}
```
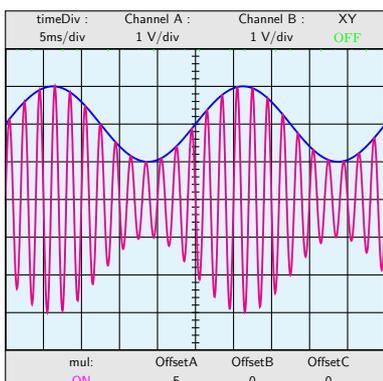
```
\psscalebox{0.5}{\Oscillo[amplitude1=1,amplitude2=1,CC2=2,
 period2=25,period1=2,combine=true,operation=mul,offset1=5]}
```
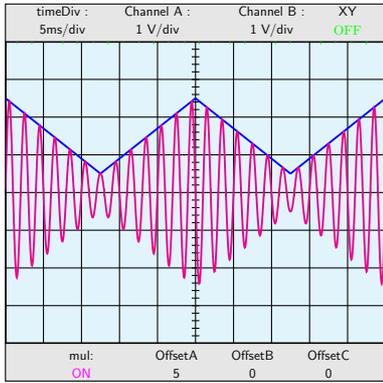
```
\psscalebox{0.5}{\Oscillo[amplitude1=1,amplitude2=1,CC2=1.5,
  Wave2=\TriangleB,
  period2=25,period1=2,combine=true,operation=mul,offset1=5]}
```
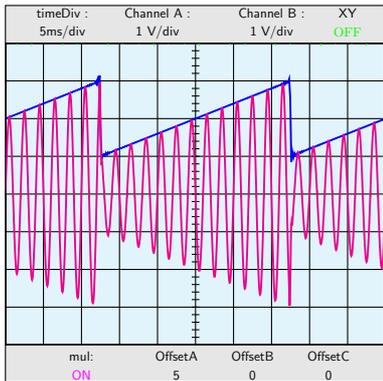


```
\psscalebox{0.5}{\Oscillo[amplitude1=1,amplitude2=1,CC2=2,
  Wave2=\RDogToothB,
  period2=25,period1=2,combine=true,operation=mul,offset1=5]}
```



```
\psscalebox{0.5}{\Oscillo[amplitude1=1,amplitude2=1,CC2=-2,
  Wave2=\LDogToothB,
  period2=20,period1=3,combine=true,operation=mul,offset1=5]}
```
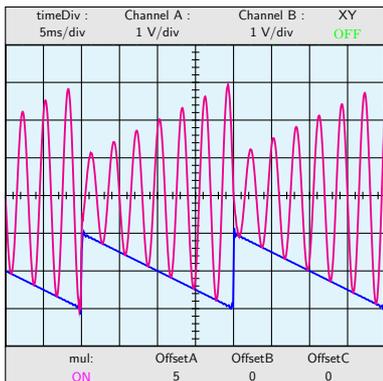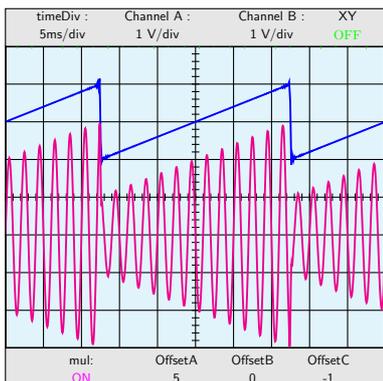


```
\psscalebox{0.5}{\Oscillo[amplitude1=1,amplitude2=1,CC2=2,
  Wave2=\RDogToothB,
  period2=25,period1=2,combine=true,operation=mul,
  offset1=5,offset3=-1]}
```
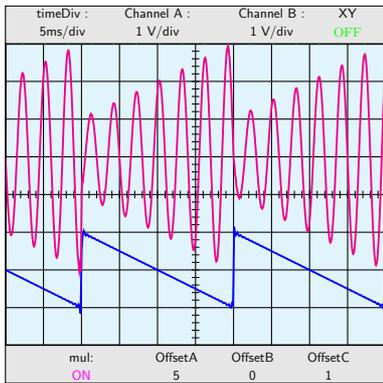
```
\psscalebox{0.5}{\Oscillo[amplitude1=1,amplitude2=1,CC2=-2,
Wave2=\LDogToothB,
period2=20,period1=3,combine=true,operation=mul,
offset1=5,offset3=1]}
```

3.6   More examples
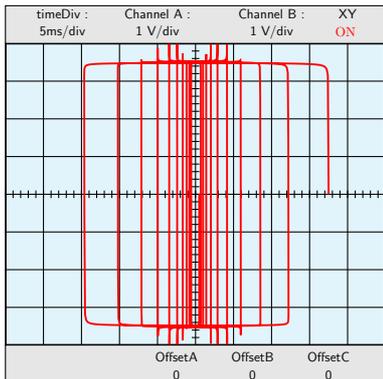
```
\psscalebox{0.5}{\Oscillo[amplitude1=3.5,phase1=90,amplitude2=3.5,
period1=50,
period2=50,phase2=0,Lissajous=true,damping1=0.01,
Wave2=\RectangleB]}
```
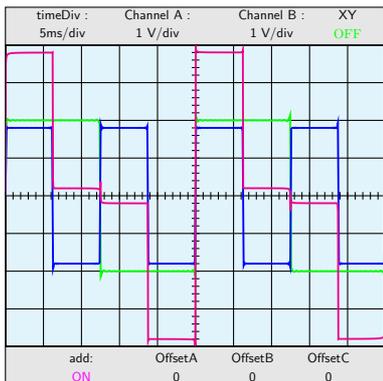
```
\psscalebox{0.5}{\Oscillo[amplitude1=2,amplitude2=1.8,
Wave1=\RectangleA,
Fourier=500,period1=25,period2=12.5,combine=true,
operation=add,Wave2=\RectangleB]}
```
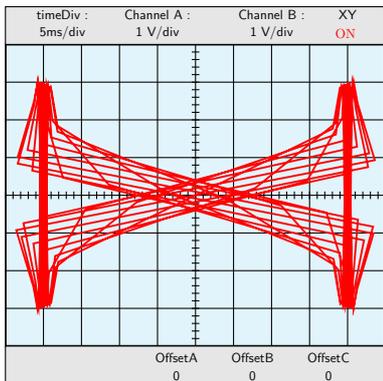
```
\psscalebox{0.5}{\Oscillo[amplitude1=4,amplitude2=3,
period1=50,
period2=5,Lissajous=true,Wave1=\RectangleA]}
```

| timeDiv : 5ms/div	Channel A : 1 V/div	Channel B : 1 V/div	XY ON
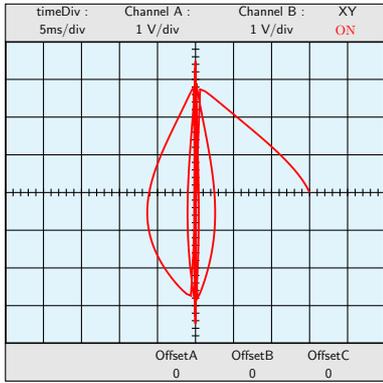
```
\psscalebox{0.5}{\Oscillo[amplitude1=3,phase1=90,
 amplitude2=3,damping1=0.05,
 period1=25,period2=12.5,phase2=0,
 Lissajous=true,Wave2=\RDogToothB]}
```

timeDiv : 5ms/div	Channel A : 1 V/div	Channel B : 1 V/div	XY ON
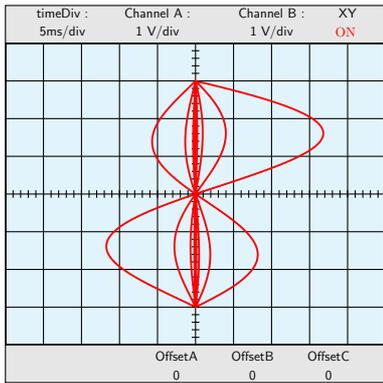
```
\psscalebox{0.5}{\Oscillo[amplitude1=4,amplitude2=3,period1=25,
 period2=50,Lissajous=true,damping1=0.02,
 Wave2=\TriangleB]}
```
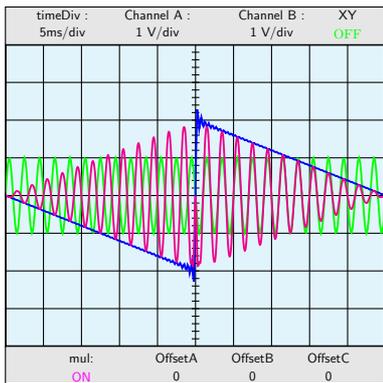
timeDiv : 5ms/div	Channel A : 1 V/div	Channel B : 1 V/div	XY OFF

```
\psscalebox{0.5}{\Oscillo[Wave2=\LDogToothB,combine=true,
 operation=mul,
 amplitude2=2,period2=50,period1=2,amplitude1=1]}
```

timeDiv : 5ms/div	Channel A : 1 V/div	Channel B : 1 V/div	XY ON
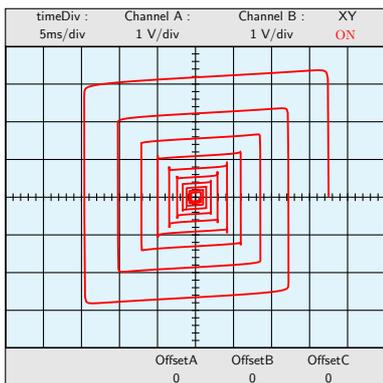
```
\psscalebox{0.5}{\Oscillo[amplitude1=3.5,phase1=90,%
 amplitude2=3.5,period1=50,
 period2=50,phase2=0,Lissajous=true,damping1=0.01,
 Wave2=\RectangleB,damping2=0.01]}
```