COMPLEX DEMODULATION ... PLOT

PURPOSE

Generates a complex demodulation plot.

DESCRIPTION

A complex demodulation plot is a graphical data analysis technique for determining if the amplitude or generating frequency changes over the course of a single-frequency time series. Complex demodulation attempts to model a time series with the following equation:

$$Y_t = A_t \sin(W_0 t + \phi_t) \qquad \textbf{(EQ 2-6)}$$

In this equation, A is the amplitude, ϕ is the phase shift, and W_0 is the complex demodulation frequency. Note that A and ϕ vary with time while the complex demodulation frequency is constant. Since A and ϕ are allowed to vary, complex demodulation is sometimes referred to as local harmonic analysis. The goal of complex demodulation is to estimate approximations for A_t and ϕi_t. The mathematical derivations for finding these estimates can be found in the books listed in the REFERENCE section below (DATAPLOT uses the Granger and Hatanaka derivation).

A complex demodulation plot consists of:

Vertical axis = estimated local amplitude or estimated local phase;
Horizontal axis = dummy index 1 to n where n is the number of observations.

The following 2 types of complex demodulation plots are available:

1. complex demodulation amplitude plot
2. complex demodulation phase plot

SYNTAX 1

COMPLEX DEMODULATION AMPLITUDE PLOT <y> <SUBSET/EXCEPT/FOR qualification>
where <y> is a variable that contains the time series observations to be analyzed;
and where the <SUBSET/EXCEPT/FOR qualification> is optional.

SYNTAX 2

COMPLEX DEMODULATION PHASE PLOT <y> <SUBSET/EXCEPT/FOR qualification>
where <y> is a variable that contains the time series observations to be analyzed;
and where the <SUBSET/EXCEPT/FOR qualification> is optional.

EXAMPLES

```
COMPLEX DEMODULATION AMPLITUDE PLOT Y
COMPLEX DEMODULATION PHASE PLOT Y
```

NOTE 1

Complex demodulation plots are typically drawn with no connected lines and with some type of character. For example,

```
LINES BLANK
CHARACTER X
```

NOTE 2

The DEMODULATION FREQUENCY command is required before entering the COMPLEX DEMODULATION PLOT command. The demodulation frequency is the W_0 parameter. A spectral plot is typically generated to get an initial estimate for the demodulation frequency.

NOTE 3

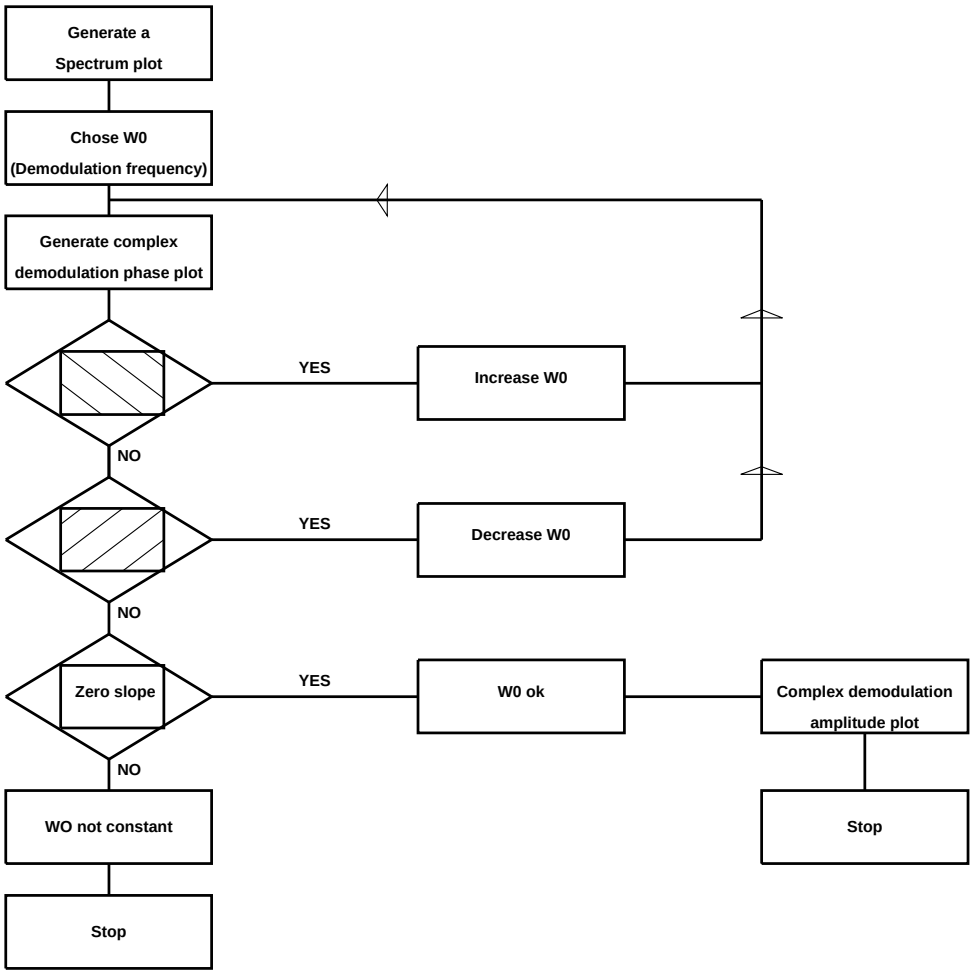
The complex demodulation plot can be used to generate a non-linear fit of the single cycle model. For example,

```
DEMODULATION FREQUENCY FREQ
LET N = SIZE Y
LET T = SEQUENCE 1 1 N
LET CONST = MEAN Y
COMPLEX DEMODULATION PHASE PLOT Y
LET FREQ = <best estimate>
COMPLEX DEMODULATION AMPLITUDE PLOT Y
```

LET AMP = best estimate
FIT Y = CONST + AMP*SIN(2*3.14159*FREQ *T + PHASE)

NOTE 4

Complex demodulation is typically done iteratively as demonstrated with the following flowchart:



DEFAULT

None

SYNONYMS

None

RELATED COMMANDS

DEMOD FREQUENCY	=	Sets the demodulation frequency for a complex demodulation plot.
DEMODF	=	A parameter where the updated demodulation frequency is stored.
SPECTRUM	=	Generates a spectral plot.
PERIODOGRAM	=	Generates a periodogram.
CORRELATION PLOT	=	Generates a correlation plot.

LAG PLOT	=	Generates a lag plot.
PLOT	=	Generates a data or function plot.
CHARACTERS	=	Sets the types for plot characters.
LINES	=	Sets the types for plot lines.
LET	=	Generates sine or cosine transformations (and much more).
FIT	=	Carries out a least squares fit.

APPLICATIONS

Frequency based time series analysis

IMPLEMENTATION DATE

Pre-1987

REFERENCE

"Spectral Analysis of Economic Time Series," Granger and Hatanaka, Princeton University Press, 1964.

"Fourier Analysis of Time Series: An Introduction," Peter Bloomfield, John Wiley and Sons, 1976 (Chapter 6).

PROGRAM

```
SKIP 25
READ LEW.DAT Y
TITLE AUTOMATIC
MULTIPLOT 2 2; MULTIPLOT CORNER COORDINATES 0 0 100 100
LINE BLANK; SPIKE ON; LET A = MEAN Y; SPIKE BASE A
PLOT Y
SPIKE OFF; LINE SOLID
SPECTRUM Y
DEMODULATION FREQUENCY .3
COMPLEX DEMODULATION AMPLITUDE PLOT Y
DEMODULATION FREQUENCY .3
COMPLEX DEMODULATION PHASE PLOT Y
END OF MULTIPLOT
```