

Demo Guide - UserMod

This paper guides you how to create user defined modulations and load them into the SMIQ or how to transfer externally generated filter coefficients into the SMIQ.

The information was taken from the UserMod online help that includes Getting Started Examples. The PC program UserMod can be downloaded from our homepage www.rohde-schwarz.com free of charge.

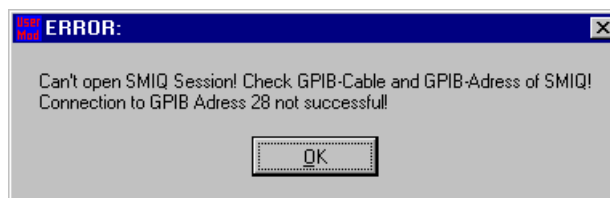
Getting Started – 8PSK

In the first example a simple 8PSK mapping is created. Entries by way of mouse and keyboard are demonstrated. The mapping is stored on the hard disk and then transferred to the SMIQ.

- **First check the configuration:**
 - An IEC/IEEE-bus card is installed and connected to SMIQ.
 - **IEC/IEEE-bus address 28** is set in the SMIQ.
 - SMIQ is switched on.

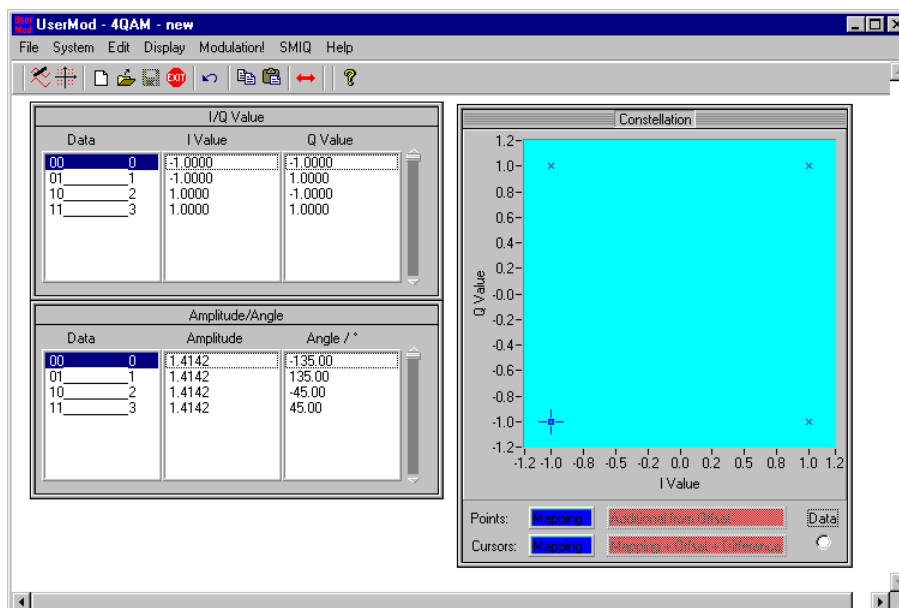
- **Start the program USERMOD.EXE.**

If the configuration is not complete, the following window is displayed:



The program can be started with OK. In this case UserMappings and UserFilter cannot however be transferred to SMIQ.

After start-up the following window is opened:



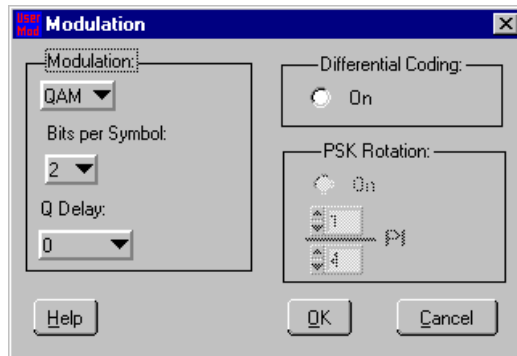
In the title bar, the selected modulation, ie 4QAM, is indicated next to 'UserMapping'. This means that QAM with 4 states is used (corresponds to 2 bits/symbol).

The windows I/Q Value, Amplitude/Angle and Constellation are open in the main window.

To create 8PSK proceed as follows:

- **Click the 'Modulation' menu..**

The following window is opened:



Here the modulation parameters can be set:

First change the modulation mode:

- **Click 'QAM' under 'Modulation:' and select 'PSK'.**

Change the bits per symbol first:

- **Click '2' under 'Bits per Symbol:' and select '3'.**

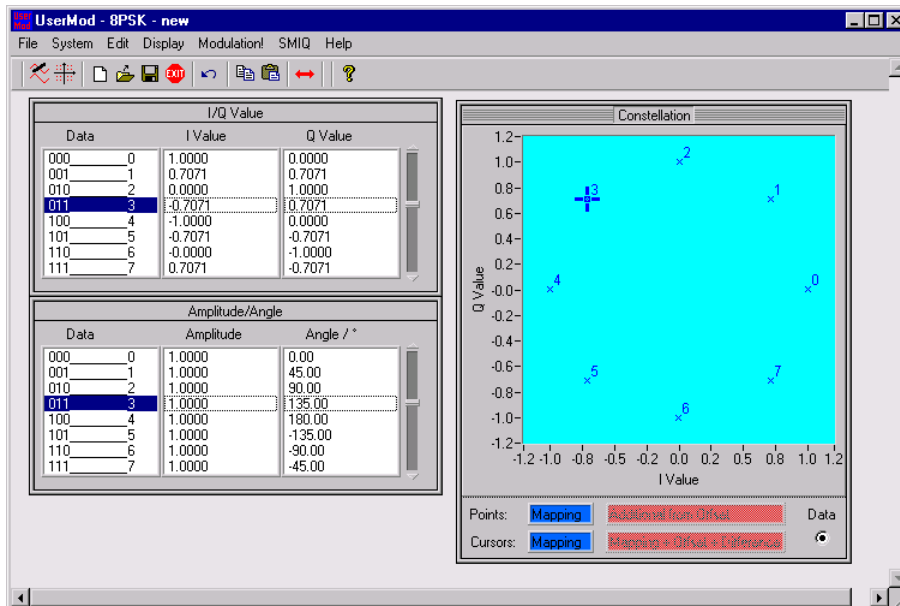
To execute the settings

- **Click 'OK'.**

The changes are displayed in the windows.

For distribution of the points equally in the I/Q plane :

- **Select 'Edit -> Regular Mapping'.**



Use the cursor to change a mapping point:

- **Place the mouse cursor near the active point, press the left mouse key and draw the point to the desired position. Observe the Amplitude/Angle values in the table.**

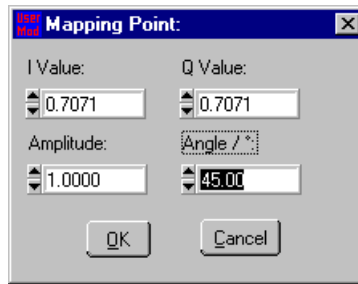
The coordinates are now displayed in the current line. It can be seen that the amplitude is always 1.

- **Set the 'Angle / °' to 0.**
- **Click the 4nd line in one of the two tables.**

Values may also be entered via the keyboard:

- **Double-click 135 in the 'Angle / °' column.**

The following input window is opened:



- **Enter 45 and then click 'OK'**

To store the created mapping

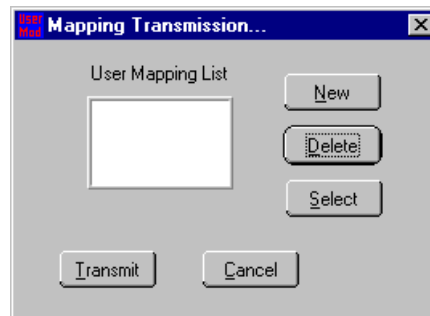
- **Click 'Save As...' in the File menu and choose the file name and path. To store the mapping click 'Save'.**

The file name with path is displayed in the title line.

To transfer the new mapping to SMIQ

- **Click 'Mapping Transmission...' in the SMIQ menu.**

The following window is opened:

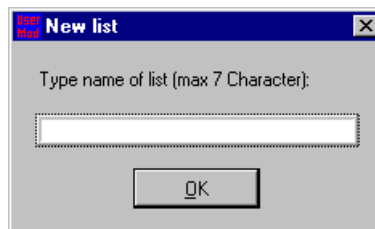


The UserMappings stored in the SMIQ are indicated in the 'UserMapping List'. A maximum of 4 UserMappings can be stored in SMIQ.

To create a new UserMapping

- **Click 'New'.**

The following entry window is opened:



- **Type the name of the UserMapping: `USR8PSK<RETURN>`**

The input window is closed and a new UserMapping is created in SMIQ which does not contain any data. To transfer the previously edited mapping into the UserMapping 'USR8PSK'

- **Click 'Transmit'.**

The UserMapping is now in the SMIQ. To switch it on

- **Open the DIGITAL MOD->MODULATION...->TYPE... menu of SMIQ and select 'USR8PSK' modulation from the list.**

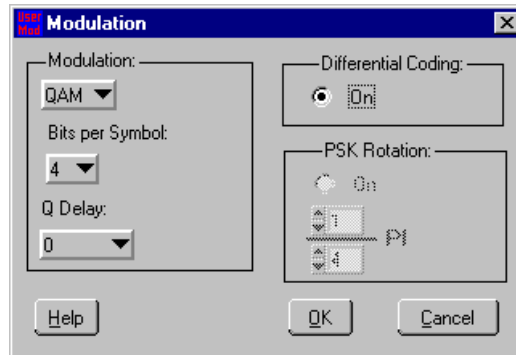
This simple example shows how to create a UserMappings in a fast way.

Differential Coding – 16QAM

In a second example differential coding shall be demonstrated:

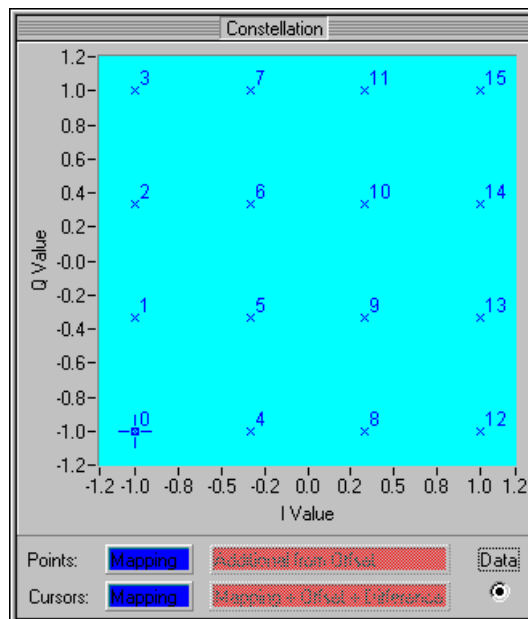
- **Start the UserMod.exe program or select 'File -> new' when you are already in UserMod.**
- **Click 'On' under 'Modulation! -> Differential coding:' to switch on differential coding.**
- **Click '2' under 'Bits per Symbol' and select '4'.**

The following modulation window is opened:

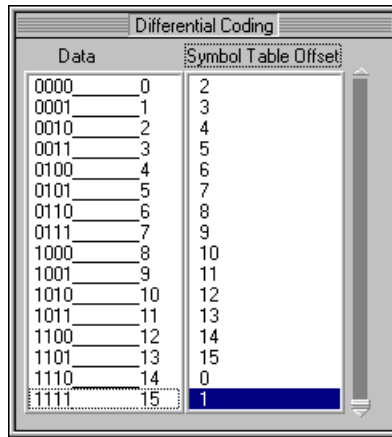


- **Click 'OK' to execute the settings.**
 - **Click 'Regular Mapping' in the 'Edit' menu.**
- An evenly distributed 16QAM mapping is displayed.
- **Click 'Data' in the 'Constellation' window.**

The number of the mapping points is now indicated in the constellation diagram.



The symbol offsets are displayed in the 'Differential Coding' table. After a double click, changes can be made in the 'Symbol Table Offset' column. After a few modifications of the offset values (and the window size) the table may look as follows:



Input data sequence (section of a PN9 sequence):

0110 0001 0011 1001 0101 0110 0001 1011 1101 0011 0111 0010 0010 1000 0101

This data sequence should demonstrate the difference between mapping with differential coding and mapping without it.

Input data		Mapping points w/o differential coding	Values in the 'Differential coding' table	Mapping points with differential coding
Bin.	dec.			
0110	6	6	8	8
0001	1	1	3	11
0011	3	3	5	0
1001	9	9	11	11
0101	5	5	7	2
0110	6	6	8	10
0001	1	1	3	13
1011	11	11	13	10
1101	13	13	15	9
0011	3	3	5	14
0111	7	7	9	7
0010	2	2	4	11
0010	2	2	4	15
1000	8	8	10	9
0101	5	5	7	0

With differential coding switched off, the input data directly indicate the mapping points.

With differential coding on, a differential value is first determined from the 'Differential Coding' table. The line number of the table is given in the input data and also indicated in the 'Data' column. The differential value is displayed in the 'Symbol Table Offset' column.

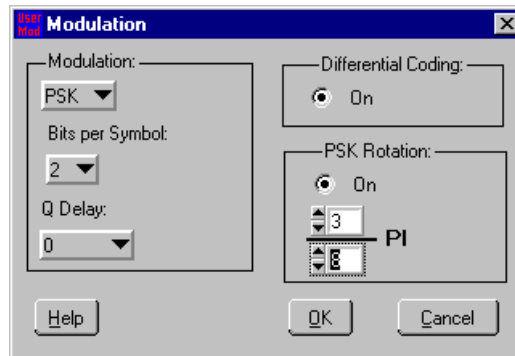
The value is then added to the last mapping point and thus the new mapping point is obtained. If the number of the new mapping point is higher than the available number of mapping points, an overflow occurs. (In this example: mapping point 16 corresponds to 0).

PSK Rotation – $3\pi/8$ DQPSK

The third example is concerned with UserMapping for PSK rotation:

- **Start the UserMod.exe program or select 'File -> new' when you are already in UserMod.**
- **Click 'Modulation' in the menu and select PSK modulation.**
- **Switch on differential coding by clicking 'On' under 'Differential Coding'.**
- **Click 'On' in the 'PSK Rotation' field for setting a rotation.**
- **Set rotation to 3 / 8.**

The following modulation window is displayed:



- **Click 'OK' for the settings to become effective.**

The symbol offsets are displayed in the 'Differential Coding' table. The values in the table can be edited as required. They inform on the number counted in the symbol table with each data word. If the absolute symbol is 01 and the input 10, the next symbol is 11 (see example/table in the previous section).

With PSK rotation switched on, a phase is added to each symbol, in this case $3/8\pi$ which corresponds to 67.5° . The PSK rotation adds points to the constellation diagram. The phase offset must however be calculated correctly so that the number of points remains within a certain limit. If too many points are created in the constellation diagram, an error message is output and PSK rotation has to be changed.

- **Store and transfer the mapping in the same way as in the 8PSK example.**

Editing mappings (unsymmetrical 16QAM)

The capability of UserMapping to shift every point as required can be utilized for generating unsymmetrical modulation. With 16QAM, 16 points would have to be shifted. This can be supported by help functions of UserMapping. An evenly distributed 16QAM mapping has to be created first.

- **Start UserMod.exe or select 'File -> new' when you are already in UserMod.**
- **Click 'Modulation', set 'Bits per Symbol' to 4 and click 'OK'.**
- **Select the menu item 'Edit->Regular Mapping'**

A 16QAM mapping is displayed with points evenly distributed in a 4x4 raster.

To change this symmetrical mapping proceed as follows:

- **Select the menu item 'Edit'->'Scale Mapping'**
- **Enter 0.8 for 'I Scale Factor' and 'Q Scale Factor' and click 'OK'.**

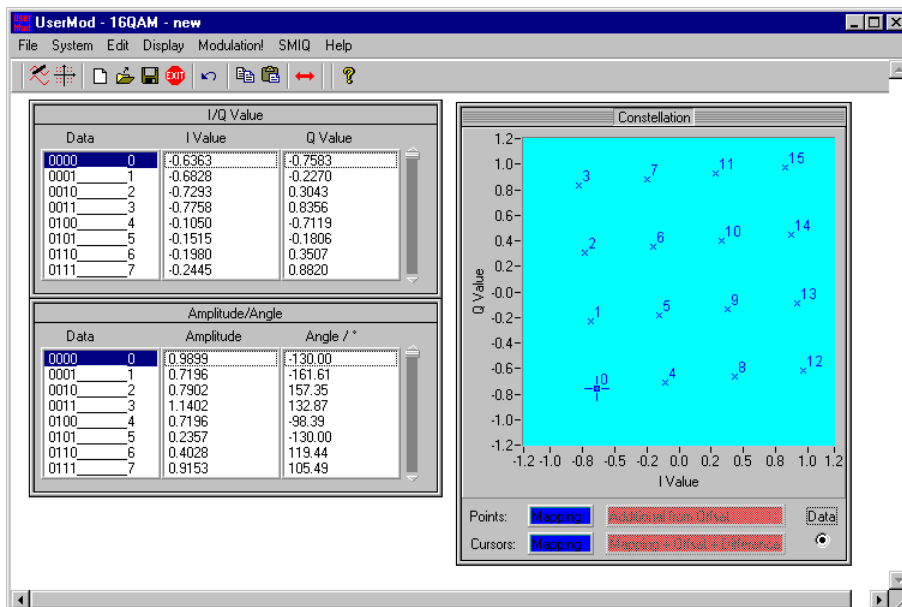
The displayed mapping is reduced by the factor 0.8.

- **Select the menu item 'Edit'->'Move Mapping'.**
- **Enter 0.1 for 'I Move' and 'Q Move' and click 'OK'.**

The mapping is shifted to the top right.

- **Select menu item 'Edit'->'Rotate Mapping'.**
- **Enter 5 for 'Angle / °' and click 'OK'.**

The mapping is rotated counterclockwise by 5°.



The sequence of points in the mapping is determined by the 'Edit->Regular Mapping' command. To change the sequence, the 'Data' field in the tables can be edited:

- **Double-click on the first line in the I/Q table.**
- **Enter 15 in the 'Decimal' field and click 'OK'.**

The value 15 is now displayed in the first line of the 'Data' column, 0 in the last. The other lines remain unchanged. To reset the mapping to normal order:

- **Select menu item 'Edit'->'Sort Mapping'.**

The first and last line are exchanged.

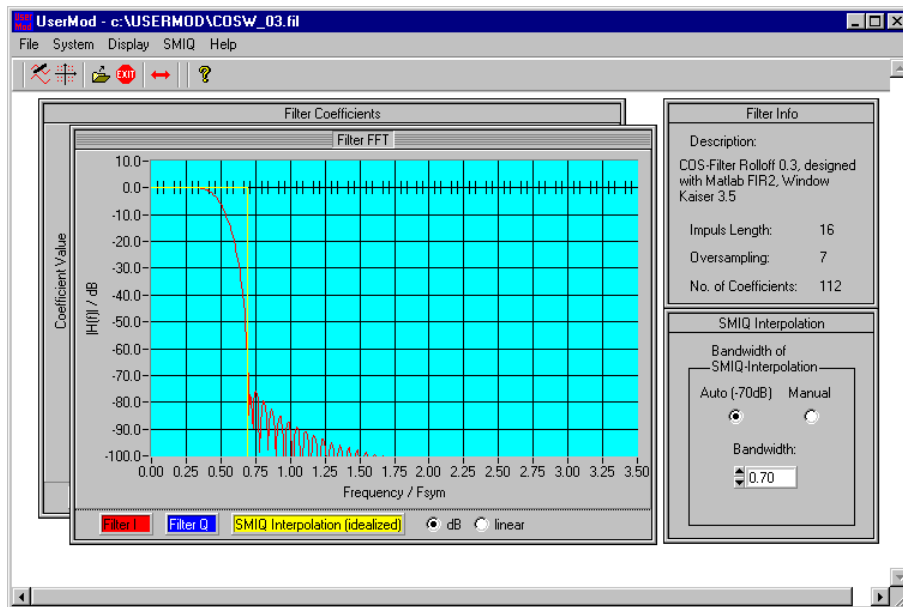
Using capabilities demonstrated in this example can be used for error simulation. An I or Q offset can for instance be created by shifting the whole mapping.

Getting Started (loading filter coefficients and transfer to SMIQ)

The following example illustrates how the file containing filter coefficients (e.g. calculated with an external mathematical software) is loaded into SMIQ with the aid of the 'UserMod' program.

- **Start the UserMod.exe program**
- **Click 'System'->'UserFilter' to switchover to the UserFilter system.**
- **Click 'File'->'Load' to load the filter.**

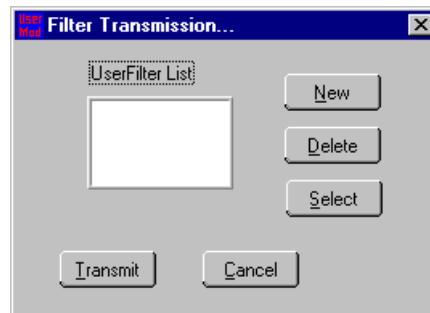
The frequency and time characteristics of the filter are displayed:



To transfer the filter to SMIQ

- **Click 'Filter Transmission...' in the SMIQ menu.**

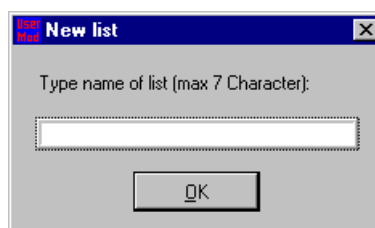
The following window is opened:



The user filters in the SMIQ are displayed in the 'UserFilter List'. A maximum of 4 user filters can be stored in SMIQ. To create a new UserFilter:

- **Click 'New'.**

The input window is opened:



- **Type the name of the user filter: e.g. `USRFILT<RETURN>`**

The input window is closed and a new UserFilter created in SMIQ which however does not contain any data. To transfer the previously loaded filter into UserFilter 'USRFILTER':

- **Click 'Transmit'.**

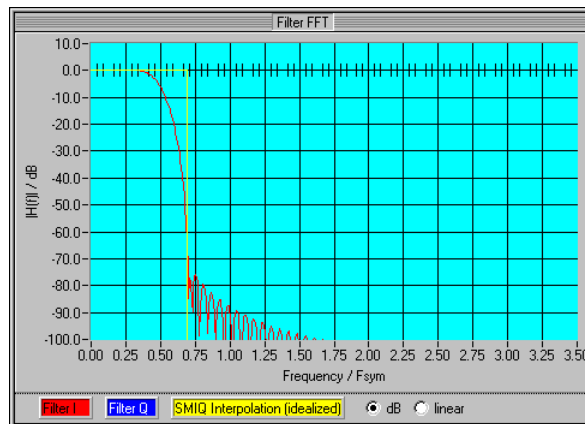
The UserFilter is now stored in SMIQ. To switch it on

- **Select the DIGITAL MOD->FILTER->TYPE... menu of SMIQ and select the 'USRFILTER' filter from the list..**

This simple example shows how to transfer a UserFilter.

Filter FFT window

The frequency response of the filter is displayed. It corresponds to FFT of the filter coefficients.

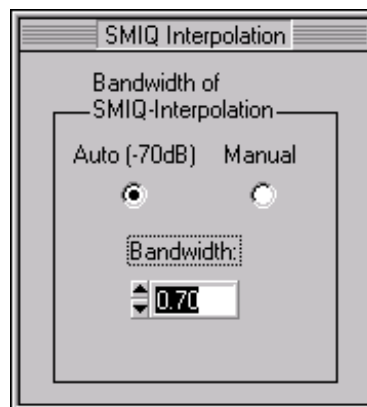


If the filter is different for I and Q, different colors will be used.

The 'Ideal Interpolation' filter schematically shows the function of the Interpolator filter in SMIQ: Below a bandwidth the UserFilter remains unchanged, above this bandwidth the interpolator filter and the UserFilter are superimposed. The 'Ripple' in the stop band range of the UserFilter is therefore not maintained in the SMIQ.

SMIQ Interpolation window

The output signal of the baseband filter is further interpolated in SMIQ. The interpolation bandwidth can be set in the SMIQ Interpolation window.



Auto / Manual:

The user can choose whether the interpolation filter of SMIQ should be set automatically (-70 dB) or whether the bandwidth of the interpolation filter is to be entered by the user.

Bandwidth:

Used with QAM and PSK. With the aid of this bandwidth, the interpolation filter is selected to ensure that the frequency response of the filter is maintained up to this frequency. With higher frequencies the stopband range of the UserFilter is superimposed onto that of the interpolation filter.