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# **Measurements of Dual-tone Multifrequency Dialling Signals with the Audio Analyzers UPL and UPD**

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Application Note 1GA23\_1L

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Subject to change

Products:

**Audio Analyzer UPL**

**Audio Analyzer UPD**



**ROHDE & SCHWARZ**

## 1. Conclusion

In modern telephoning, dual-tone dialling is used more and more often. Every symbol to be transmitted is coded by two frequencies which are sent at the same time. To ensure a trouble-free call setup, transmission has to be done within defined tolerances. For measuring these kind of dialling signals, the measurement equipment has to fulfill high requirements. This application note describes how the measurements can be carried out by using the Audio Analyzers UPL or UPD. It also presents a measuring program for this application.

## 2. Dual-tone multifrequency dialling

In addition to the well-proven pulse dialling, dual-tone dialling is more and more often applied in modern telephoning. In this dialling technique, every symbol to be transmitted is coded by a short tone signal consisting of two frequencies that are sent at the same time. Frequency pairs are formed as shown in the diagram. The columns and lines of the telephone keypad are characterized by a frequency. The lines are assigned frequencies between 600 Hz and 1 kHz whereas the columns between 1.2 and 1.7 kHz. By a combination of line and column frequency, each character is clearly defined.

Frequency coding of lines	f1 697 Hz	1	2	3	A
	f2 770 Hz	4	5	6	B
	f3 852 Hz	7	8	9	C
	f4 941 Hz	*	0	#	D
		f5 1209 Hz	f6 1336 Hz	f7 1477 Hz	f8 1633 Hz
		Frequency coding of columns			

To ensure a trouble-free call setup, frequency pairs have to be transmitted within defined tolerances. For Germany, the following specifications are required according to FTZ regulation 1 TR 2 part 2:

- maximum permissible frequency drift  $\pm 1.8\%$  from nominal value
- the sum level (rms value) of the two signal frequencies is -4.5 dBu with a tolerance of  $\pm 2.5$  dB measured using standard termination
- the two tones are transmitted with preemphasis, ie the upper frequency group has a level which is 2 dB higher than that of the lower (tolerance  $\pm 1.5$  dB).
- the S/N ratio of the signal has to be higher than 26 dB (in frequency range 4 to 28 kHz).
- the signal timing is 80 to 100 ms per character followed by a 80 to 100 ms pause. It has to be made sure that the minimum duration of a character is not less than 40 ms.

Similar specifications can be found in the regulations of other countries with for example the length of characters defined differently. The above values are thus simply given as an example.

### **3. Measurement problem**

When dialling signals are to be measured it has to be ensured that the dialling oscillator is terminated with the correct impedance. In practice, this is normally done by means of an artificial telephone line which is connected to the measuring instrument.

The specification values listed above indicate the stringent requirements of such measurements.

Frequencies and levels have to be measured with a high accuracy. The signal generally appears only once and lasts for less than 100 ms. Most of the FFT analyzers cannot cope with this task as the time available for the measurement is not enough to take a sufficient number of samples for the required frequency resolution.

### **4. Solutions provided by Audio Analyzer UPL and UPD**

The measurement problem can be solved by using Audio Analyzer UPL or UPD. The level step occurring on the start of the dialling signal is used for triggering the analyzer. A two-tone signal duration of >40 ms is sufficient to collect the values for a 1-k FFT. In this case, a frequency resolution of only 47 Hz is obtained, ie much too coarse for an accurate frequency determination. However, the UPL/UPD uses a special interpolation method for FFT analysis allowing signals to be determined much more accurately in their frequency and level. Provided that the signals are sine curves and using HANN or Rife-Vincent windows, several FFT lines can be used in a defined frequency band to calculate the maximum value. These prerequisites are provided with UPL/UPD. The interpolation method allows a level accuracy of better than 1% and the frequency to be determined to exactly 0.1 Hz (typical values). Therefore, UPL/UPD far exceeds the requirements for measuring dialling signals.

## 5. Measurement using Application Program DTMF.BAS

Application program DTMF.BAS is available for testing dual-tone multifrequency dialling signals. The program runs on Audio Analyzer UPD/UPL under the optional Universal Sequence Controller UPD-K1 respectively UPL-B10.

After activating the Universal Sequence Controller the program has to be loaded and started under BASIC by means of the F3 key. Setup DTMF.SAC is then loaded and the program awaits the dialling signal.

On the start of the dialling signal the measurement will run as follows:

- the analyzer is started by the incoming dialling signal by means of trigger function START COND LEV TRG CH1. A FFT analysis is performed once (512 points, zoom factor 2, measurement time approx. 28 ms) using the Rife-Vincent-2 window
- then, ie without the dialling signal being present, evaluation is started
- the first maximum is searched in the frequency range 600 to 1000 Hz and is exactly determined by means of interpolation in level and frequency.
- the second maximum in the range from 1.2 to 1.7 kHz is determined in the same way
- the transmitted character is then displayed by means of the two frequencies
- the frequency drift from the nominal values is calculated and displayed in %.
- the two level values are displayed.
- based on the results of FFT, the sum level of the frequency pair as well as the preemphasis can now be calculated and displayed together with the relevant drifts from the nominal value
- the total rms value without the two signal components is determined from the FFT results, compared with the dialling signal and displayed as the S/N ratio. It has to be noted that the S/N value is with reference to frequency range 200 Hz to 22 kHz.

After evaluation of the results the program awaits the next dialling signal to immediately start another measurement.

The program can be stopped by simultaneously pressing keys Ctrl and Break.

The program including the corresponding setup can be ordered from your local Rohde & Schwarz sales office.

Best would be to install the directory C:\TELEPHON on the UPL/UPD and to copy the program and the setup into this directory. Otherwise you have to change the line "WORK DIR" in the setup accordingly.