sound reinforcement & microphones

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statement
most SR-systems work perfectly
- until a microphone is connected....

content
• SR and microphones – what are the challenges
• microphones – what’s that?
• specs – known and less known
• microphones and soundfield
• measurement methods

the challenge

challenge: no positive feedback

challenge: sufficient amplification
challenge: make the artist shine

challenge: stage monitoring

challenge: source separation

challenge: SR + recording / broadcast

challenge: arrays and off axis response

the stage is an important listening area

challenge: sometime invisible mics
challenge: “Interesting” venues

challenge: uniformity of units

challenge: rugged gear needed

challenge: the weather...

challenge: no handling noise.....
microphone design

sound particle displacement vs membrane displacement (@1kHz)

pressure microphone

membrane manometer

the pressure is measured no matter the direction of the membrane

going the polar plots

high frequency lift + directivity

set up for the measurement of polar plot

on axis response (free field)
diffuse field response
directional characteristic, omni

DPA d:scree 4060 / 4061

pressure gradient microphone

pressure difference between to points

pressure difference between to points

correction:
Mechanical: a more sloppy membrane
Electrical: lowpass, 6 dB / octave

at this frequency the microphone normally turns into a pressure microphones
influence of distance relative to source

the back of the membrane is further away compared to the front. hence we can have an additional difference - or gradient.

pressure gradient due to distance

this is the raw frequency response before correction (near sound source)

pressure gradient due to distance

frequency response after correction (near sound source)

pressure gradient microphone

proximity – how much?

figure 8 (rotated)
proximity (pressure gradient microphone)

microphone (cardioid)

flat response for distant sound sources (>1 meter)

proximity (handheld vocal microphone (cardioid))

flat response close to the source (<0.1 meter)

proximity

handheld vocal microphone (cardioid)

no proximity effect when angle of incidence is approximately 90 degrees

acoustical principles

by the acoustical coupling between front and back of membrane various characteristics are achieved:

closed space behind membrane: pressure microphone directional characteristic: omni

open space behind membrane: pressure gradient microphone directionality: figure 8 → cardioid

an example
Reduction of distant sound sources

Cardioid vs. omni in theory

Damping of distant sources (distance > 1 m)

Response of omnidirectional microphone
Response of cardioid microphone

Reduction of distant sound sources using headband pressure gradient microphone
DPA 4088 compared to DPA 4066; measured data

Microphone specs

Introduction - what to specify?

- It's FAT
  - (There is no such thing as a low-fat microphone.... jk)
- It sounds COOL
- It's PINK
- It's OLD!! (wauw)
- All the others are using it
- It's CHEAP
- Or
- It's EXPENSIVE

Or: IEC 60268-4

Is a measurement standard, not a performance standard
No manufacturer uses all of it

The microphone

Membrane
Transducer
Input

Coupling to the soundfield
Dynamic (coil, ribbon)
Condenser (HF, electret)
Digital

Pressure
Pressure gradient
Other

Analogue
Other
basic electrical specifications

• sensitivity – determines preamp requirements
• frequency response – is it wide or narrow enough?
• directivity pattern – sound pickup from where?
• THD/clip – can the microphone handle the SPL?
• noise level – quieter than recording ambient level?
• power requirements – can the preamp supply?
• impedance – does the cable and preamp affect signal?
• pop noise / wind noise? Other specs?

microphone sensitivity

sensitivity

94 dB re 20μPa
(= 1 Pascal)

RMS vs peak

the figure shows three signals with identical peak-to-peak values

- but different RMS-values.

check SPL

Peak level

155 dB
Det senest hørte danner reference for det næste voice-
voice level

152.4 dB re 20 uPa, peak!!!!!!

<table>
<thead>
<tr>
<th>Peak (unweighted)</th>
<th>dB</th>
<th>RMS (A-weighted)</th>
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</thead>
<tbody>
<tr>
<td>Saxophone trumpet @ 0.5 m</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>Inside helicopter</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Indoor choir, side shelf</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Saxophone recording</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Trumpet recording</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Bass drum @ front skin, taped</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Violin @ ear</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>Single string picking of Spanish guitar</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Outdoor rock concert (maximum, maximum)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Grand piano @ 3 meter (lid open)</td>
<td>90</td>
<td></td>
</tr>
</tbody>
</table>

microphone directivity

getting the polar plots

set up for the measurement of polar plots
tracking the cardioid…

A polar plot/diagram is used to show how certain frequencies are reproduced when they enter the microphone from various angles.

The same microphone – but different scalings.

Directionality:

Directivity Index (DI) = 10 * log directivity factor
directivity index (DI)

microphone & soundfield

point source, in reverberant field

directivity in practice
It turns more or less to an omni.

Reference: Martin Schneider
wireless transmission, analog, compander

what have we? 3 volt + 5 volt?
48 volt? - few systems
(it's a work of art to make condenser microphone heads for handheld wireless transmitters work as well as when connected to a genuine 48 v phantom supply.)

acoustical modelling

microphone, phase & polarity

polarity (pin 2 is positive when the pressure is positive)
magnitude and phase (handheld vocal, dynamic)

dynamic mic.

magnitude and phase (handheld vocal condenser)

magnitude and phase (handheld vocal condenser)

magnitude and phase (handheld vocal condenser)

magnitude and phase (handheld vocal condenser)

magnitude and phase (instrument condenser)
polarity & latency

WinMLS measurement

<table>
<thead>
<tr>
<th>Brand</th>
<th>Transmitter</th>
<th>Band</th>
<th>bit/kHz</th>
<th>Encr</th>
<th>Polarity</th>
<th>Latency</th>
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<tbody>
<tr>
<td>AKG</td>
<td>DMS800</td>
<td>UHF</td>
<td>24/48</td>
<td>612 bit</td>
<td>N</td>
<td>4.0 ms</td>
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<tr>
<td>Audio-Technica</td>
<td>System 10 pro</td>
<td>2.4 GHz</td>
<td>24/48</td>
<td>N 3.8 ms</td>
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<td></td>
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<td>Beyerdynamic</td>
<td>TG1000</td>
<td>UHF</td>
<td>16 bit</td>
<td>x</td>
<td>P</td>
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<td>Lectrosonics</td>
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<tr>
<td>Line 6</td>
<td>TB2, XD-V70</td>
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<td>24/48</td>
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<tr>
<td>Mipro</td>
<td>ACT-8000</td>
<td>UHF/2.4 GHz</td>
<td>?</td>
<td>?</td>
<td></td>
<td></td>
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<tr>
<td>Sabine / Sacom</td>
<td>DS8000</td>
<td>256 bit</td>
<td>?</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sennheiser</td>
<td>EW D1</td>
<td>2.4 GHz</td>
<td>256 bit</td>
<td>N 3.8 ms</td>
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<td></td>
</tr>
<tr>
<td>Sony</td>
<td>DWT 801</td>
<td>SD/HD</td>
<td>24/48</td>
<td>P 4.0 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sony</td>
<td>ZTX B02RC</td>
<td>2.4 GHz</td>
<td>128 bit</td>
<td>N 7.0</td>
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</tr>
<tr>
<td>Sony</td>
<td>ZTX B02RC</td>
<td>2.4 GHz</td>
<td>128 bit</td>
<td>N 3.6/3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trantec</td>
<td>SD7000</td>
<td>128 bit</td>
<td>?</td>
<td>7.0</td>
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<tr>
<td>Wisdom</td>
<td>MTP30</td>
<td>48 bit/48 kHz</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Zaxcom</td>
<td>TRX 900, TRX 900 LTS</td>
<td>256 bit</td>
<td>P 7.7</td>
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</tbody>
</table>

feed back measurement

measurement: NT ACOU 108

summing up

- many parameters have an influence on the performance
- one over-all goal is smoothness
- the microphone is difficult to evaluate from the spec sheet
- however, sensitivity, and frequency can always be checked
- check for structure borne sound
- wireless systems and condensers; make sure the performance is optimum

thank you!

check this out:
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