BALANCING AUDIO

On Campus
Objectives

• Signal flow
• Line level
• Mic level
• Decibels
• Gain staging
• Balancing input and output
• Calculating input gain
Signal Flow

• Starts with sound source
• Transducer
• Preamp stage
• Amplifies signal (mic or line)
• A/D conversion
• Processing
• Routing
Signal Flow

• D/A conversion
• To amps
• Speakers
• Listeners
Signal Flow with Mixer

1. Sound Source
   - Sound Waves
2. Microphone Signal
   - Electric Waves
3. Console Pre Amps
   - Analog to Digital Audio Interface
     - Computer DAW
     - Digital to Analog Interface
4. Power Amp
5. Speakers
Mic Input Level

• The voltage of signal generated by a microphone is the lowest or weakest level
• Requires a preamplifier to bring it up to line level
• -60 to -50 dBu (.001 to .002 V)
Line Input Level

• Line level signals are the highest level signal before amplification.
• The type of signal that flows through the system after the preamp stage
• The two types of line levels are consumer and professional
• +4 dBu or -10 dBV
Line Input Level

- $0 \text{ dBu} = 0.775 \text{ volts}$
- $+4 \text{ dBu} = 1.23 \text{ volts}$
- $-10 \text{ dBV} = 0.316 \text{ volts or } 316 \text{ mV}$
- Mic $-60 \text{ to } -50 \text{ dBu (.001 to .002 V)}$
Instrument Input Level

• Instrument level falls between mic level and line level
• Output level of an instrument usually guitar or bass
• A preamp is required to bring the signal up to line level
Speaker Level

- Speaker level signals are post amplification.
- Signal is much higher in voltage than line level, requires speaker cable.

Example

- 1,000 watts feeding an 8-ohm load would require an 89.4 volt level.
Decibels

• Five flavors of Decibels
• dB – relative value
• dBu – measured in volts
• dBV – measured in volts
• dBFS – Full Scale digital
• dB-SPL – Sound Pressure Level of output in the atmosphere
Decibels

- Decibel or dB
- Logarithmic ratio between two values
- Used in audio
- Dimensionless Value
- Relationship between two numbers
- Or comparing amplitude of two audio signals
Decibels

• Amplitude is the same 0 dB apart
• 6 dB increase is a doubling of amplitude
• Another 6 dB is a four times increase in amplitude
• Turn up 60 dB is 1000 times increase
dBu and dBV

- dBu and dBV
- Measurable value
- Measured in voltage
- 0 dBu is our optimal output level
dBu and dBV

- $0 \text{ dBu} = 0.775 \text{ V}$
- $+4 \text{ dBu} = 1.23 \text{ V}$
- $0 \text{ dBV} = 1 \text{ V}$
- $-10 \text{ dBV} = 0.316 \text{ V} (316 \text{ mV})$
How much input gain is being applied?

+6dB = 2x voltage
-6dB = ½ voltage
dBFS

• dBFS – decibel relative to full scale
• Full Scale, or max output level
• Used to measure digital audio signal levels
• Dimensionless value, can’t be converted directly to a voltage.
• 0 dBFS clipping point in digital audio
• Varies depending on manufacturer
dB-SPL

- SPL – Signal Pressure Level
- Sound pressure in the atmosphere
- SPL Meter
SPL Levels

• Quiet room = 38-40 dB-SPL
• Room with air handler = 45-50 dB-SPL
• Conversation = 66-70 dB-SPL, 1 meter
• Sound system preforms best at 30 dB above ambient noise
<table>
<thead>
<tr>
<th>Sound source</th>
<th>dB SPL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colt 45 pistol - 8 meters</td>
<td>140</td>
</tr>
<tr>
<td>Threshold of pain</td>
<td>130</td>
</tr>
<tr>
<td>Rock Concert</td>
<td>120</td>
</tr>
<tr>
<td>Night club music</td>
<td>110</td>
</tr>
<tr>
<td>Chainsaw / Jet ski</td>
<td>100</td>
</tr>
<tr>
<td>Lawnmower</td>
<td>90</td>
</tr>
<tr>
<td>Cabin of jet aircraft cruising</td>
<td>80</td>
</tr>
<tr>
<td>Car - 10 meters</td>
<td>70</td>
</tr>
<tr>
<td>Average conversation - 1 meter</td>
<td>60</td>
</tr>
<tr>
<td>Average suburban home (night)</td>
<td>50</td>
</tr>
<tr>
<td>Quiet auditorium</td>
<td>40</td>
</tr>
<tr>
<td>Quiet whisper - 1.5 meters</td>
<td>30</td>
</tr>
<tr>
<td>Extremely quiet recording studio</td>
<td>20</td>
</tr>
<tr>
<td>Anechoic Chamber</td>
<td>10</td>
</tr>
<tr>
<td>Threshold of hearing</td>
<td>0</td>
</tr>
</tbody>
</table>
Gain Staging

• Foundation of audio system
• Must be set right
• Looking for 30 dB-SPL above ambient noise
• SPL Meter
• 0 dBu or .775 volts output
Mic Input Gain

• Handheld Vocals = 35 dB minimum
• Handheld Presentation = 45 dB
• Gooseneck mic = 45 dB
• Boundary mic = 55 dB
• Farther away = 60 dB+
Input

• Normal conversation dB-SPL is around 65 to 70 dB-SPL
• Presenter is around 78 dB-SPL
• Most preamps provide 60 dB of gain
• Inverse square law
Reverse Square Law

- 1 meter (3 feet) talking 66 dB-SPL
- .5 meter (18 inches) talking 72 dB-SPL
- .25 meter (9 inches) talking 78 dB-SPL
Pascal

• Unit of Pressure or stress

Mic Sensitivity

• $1 \text{ Pa} = 94 \text{ dB-SPL}$
Mixer Specifications
SPECIFICATIONS

Measurement Conditions (unless otherwise specified): Line voltage 120 Vac, 60 Hz (SCM268) or 230 Vac, 50 Hz (SCM268E); full gain; 1 kHz, one channel activated; source impedances: Mic 150 Ω, Aux Level 150 Ω; terminations: Line 600 Ω, Mic 600 Ω, Aux Out 10 kΩ. 12 V phantom power off.

Frequency Response (Ref 1 kHz, controls centered)

Microphone Inputs: 150 Hz to 20 Khz + 2 dB (built-in 80 Hz low-cut)
Auxiliary Inputs: 20 Hz to 20 kHz + 2 dB

Low-Cut Filter (Microphone inputs only)
3 dB down at 80 Hz, 6 dB/octave

Gain (typical, controls full clockwise)

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<tr>
<th>Input</th>
<th>Mic</th>
<th>Line</th>
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<tr>
<td>Low-impedance mic (150 Ω)</td>
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Outputs

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<thead>
<tr>
<th>Output</th>
<th>Impedance</th>
<th>Designed for use with</th>
<th>Actual (typical)</th>
<th>Output Clipping Level</th>
</tr>
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<tbody>
<tr>
<td>Mic</td>
<td>low-Z inputs</td>
<td>0.2 Ω</td>
<td>0.2 Ω</td>
<td>-21 dBV</td>
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<tr>
<td>Line</td>
<td>&gt;600 Ω</td>
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Total Harmonic Distortion
<0.25% at +4 dBu output level (through 22 Hz–22 kHz filter; Input 1 and Master centered, all other controls full counter clockwise)

Hum and Noise (150 Ω source; through 22 Hz–22 kHz filter)
Equivalent Input Hum and Noise: −124 dBV

Output Hum and Noise (through 22 Hz–22 kHz filter; channel controls full counterclockwise)
Master full counterclockwise: −92 dBV
Master full clockwise: −70 dBV

Common Mode Rejection
>80 dB at 1 kHz

Polarity
All inputs to all outputs are non-inverting

Overload and Shorting Protection
Shorting outputs, even for prolonged periods, causes no damage. Microphone inputs are not damaged by signals up to +10 dBV; Auxiliary inputs by signals up to +36 dBV
Microphone Sensitivity

- The standard reference SPL is a 1,000Hz tone at 94 dB-SPL at the mic capsule.

- 94 dB-SPL equals 1 Pascal

- Sensitivity is expressed as the mic's output voltage in at either 1 Pascal or 94 dB-SPL

- The notation used may vary depending on microphone Manufacturer
SM58® Cardioid Dynamic Microphone

Overview
The legendary SM58® is an industry-standard, highly versatile cardioid dynamic vocal microphone that is consistently the first choice of vocal performers around the globe. Even in extreme conditions, the SM58 is tailored to target the main sound source while minimizing background noise, delivering warm and clear vocal reproduction.

Features
- Frequency response tailored for vocals, with brightened midrange and bass rolloff
- Uniform cardioid pickup pattern isolates the main sound source and minimizes background noise
- Pneumatic shock-mount system cuts down handling noise
- Effective, built-in spherical wind and pop filter
- Supplied with break-resistant stand adapter which rotates 180 degrees
- Legendary Shure quality, ruggedness and reliability
- Cardioid (unidirectional) dynamic
- Frequency response: 50 to 15,000 Hz

Available Models
- SM58-LC: Includes Stand Adapter and Zippered Pouch
- SM58-CN: Includes 7.6 m (25 ft) XLR-Male to XLR-Female Cable, Swivel Adapter and a Zippered Pouch
- SM58S: Includes Integrated On/Off Switch, Swivel Adapter and a Zippered Pouch

Specifications
<table>
<thead>
<tr>
<th></th>
<th>Dynamic</th>
</tr>
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<tbody>
<tr>
<td>Type</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Frequency Response</td>
<td>50 to 15,000 Hz</td>
</tr>
<tr>
<td>Polar Pattern</td>
<td>Cardioid</td>
</tr>
</tbody>
</table>
| Sensitivity (at 1,000 Hz Open Circuit Voltage) | -54.5 dBV/Pa (1.85 mV)  
1 Pa = 94 dB SPL |
| Impedance                 | Rated impedance is 150Ω (300Ω actual) for connection to microphone |
|                          | inputs rated low impedance |
| Polarity                  | Positive pressure on diaphragm produces positive voltage on pin 2 with respect to pin 3. |
| Case                      | Dark gray, enamel-painted, die cast metal; matte-finished, silver colored, spherical steel mesh grille |
| Connector                 | Three-pin professional audio connector (male XLR type) |
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| Net Weight                | 298 grams (10.5 oz) |
| Dimensions                | 162 mm (6-3/8 in.) L x 51 mm (2 in.) W |
SM58® Cardioid Dynamic Microphone

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<td>Sensitivity (at 1,000 Hz Open Circuit Voltage)</td>
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Calculating Input Gain

- Level at mic
- Mic reference level
- Mic sensitivity
- dBV to dBu conversion
- Output level = 0 dBu
- Preamp gain required
Calculating Input Gain

Level at mic: 78 dB-SPL
Mic ref level: 94 dB-SPL
Mic Sensitivity: + dBV
dBV to dBU: + 2.2 conversation
Output level: 0 dBu
Gain required: dB gain
Mic Preamp Gain

Shure SM58

Level at mic 78 dB-SPL
Mic ref level - 94 dB-SPL
Mic Sensitivity + -54.5 dBV
dBV to dBU + 2.2
Output level - 0 dBu
Gain required = -68.3 dB
SPECIFICATIONS

Measurement Conditions (unless otherwise specified): Line voltage 120 Vac, 60 Hz (SCM268) or 230 Vac, 50 Hz (SCM268E); full gain; 1 kHz, one channel activated; source impedances: Mic 150 Ω, Aux Level 150 Ω; terminations: Line 600 Ω, Mic 600 Ω, Aux Out 10 kΩ. 12 V phantom power off.

Frequency Response (Ref 1 kHz, controls centered)
- Microphone Inputs: 150 Hz to 20 KHz + 2 dB (built-in 80 Hz low-cut)
- Auxiliary Inputs: 20 Hz to 20 kHz + 2 dB

Low-Cut Filter (Microphone inputs only)
- 3dB down at 80 Hz, 6 dB/octave

Gain (typical, controls full clockwise)

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<th>Input</th>
<th>Impedance</th>
<th>Designed for use with</th>
<th>Actual (typical)</th>
<th>Input Clipping Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mic</td>
<td>19-600 Ω</td>
<td>1.2 kΩ</td>
<td>−5 dBV</td>
<td></td>
</tr>
<tr>
<td>Aux Level</td>
<td>32 kΩ</td>
<td>21 kΩ</td>
<td>&gt;28 dBV</td>
<td></td>
</tr>
</tbody>
</table>

Outputs

<table>
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<tbody>
<tr>
<td>Mic</td>
<td>low-Z inputs</td>
<td>0.2 Ω</td>
<td>870 Ω</td>
<td>+7 dBV</td>
</tr>
<tr>
<td>Line</td>
<td>&gt;600 Ω</td>
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<td>+18 dBV</td>
<td></td>
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Total Harmonic Distortion
- <0.25% at +4 dBu output level (through 22 Hz–22 kHz filter; Input 1 and Master centered, all other controls full counter clockwise)

Hum and Noise (150 Ω source; through 22 Hz–22 kHz filter)
- Equivalent Input Hum and Noise: −124 dBV

Output Hum and Noise (through 22 Hz–22 kHz filter; channel controls full counterclockwise)
- Master full counterclockwise: −92 dBV
- Master full clockwise: −70 dBV

Common Mode Rejection
- >80 dB at 1 kHz

Polarity
- All inputs to all outputs are non-inverting

Overload and Shorting Protection
- Shorting outputs, even for prolonged periods, causes no damage.
- Microphone inputs are not damaged by signals up to +10 dBV;
- Auxiliary inputs by signals up to +36 dBV
UNIDIRECTIONAL CONDENSER BOUNDARY MICROPHONE

- Designed for surface-mount applications such as high-quality sound reinforcement, professional recording, television, conferencing and other demanding sound pickup situations.

- UniGuard™ RFI-shielding technology offers outstanding rejection of radio frequency interference (RFI).

- Superior off-axis rejection for maximum gain before feedback.

- Small-diameter UniPoint capsule near boundary eliminates phase distortion and delivers clear, high-output performance.

- Heavy die-cast case and non-slip silicon foam bottom pads minimize coupling of surface vibration to the microphone.

- Low-profile design with low-reflectance finish for minimum visibility.

- AT871UG has contained electronics eliminate need for external power module.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>Fixed-charge back plate permanently polarized condenser</th>
</tr>
</thead>
<tbody>
<tr>
<td>POLAR PATTERN</td>
<td>Half-cardioid (cardioid in hemisphere above mounting surface)</td>
</tr>
<tr>
<td>FREQUENCY RESPONSE</td>
<td>30-20,000 Hz</td>
</tr>
<tr>
<td>OPEN CIRCUIT SENSITIVITY</td>
<td>-33 dB (19.9 mV) re 1V at 1 Pa</td>
</tr>
<tr>
<td>IMPEDANCE</td>
<td>200 ohms</td>
</tr>
<tr>
<td>MAXIMUM INPUT SOUND LEVEL</td>
<td>130 dB SPL, 1 kHz at 1% T.H.D.</td>
</tr>
<tr>
<td>DYNAMIC RANGE (typical)</td>
<td>103 dB, 1 kHz at Max SPL</td>
</tr>
<tr>
<td>SIGNAL-TO-NOISE RATIO</td>
<td>67 dB, 1 kHz at 1 Pa</td>
</tr>
<tr>
<td>PHANTOM POWER REQUIREMENTS</td>
<td>9-52V DC, 2 mA typical</td>
</tr>
<tr>
<td>WEIGHT (less cable)</td>
<td>415 g</td>
</tr>
<tr>
<td>DIMENSIONS</td>
<td>120.0 mm - maximum width, 145.0 mm - maximum length, 17 mm - height</td>
</tr>
<tr>
<td>OUTPUT CONNECTOR</td>
<td>TB3M-type</td>
</tr>
<tr>
<td>CABLE</td>
<td>7.6m long, 3.2mm diameter, 2-conductor shielded cable with TA3F-type connector and XLRM-type connectors.</td>
</tr>
<tr>
<td>OPTIONAL INTERCHANGEABLE ELEMENTS</td>
<td>AT853H-ELE hypercardioid (100°)</td>
</tr>
<tr>
<td></td>
<td>AT853C-ELE cardioid (120°)</td>
</tr>
<tr>
<td></td>
<td>AT853SC-ELE subcardioid (170°)</td>
</tr>
<tr>
<td></td>
<td>AT8530-ELE omnidirectional (360°)</td>
</tr>
<tr>
<td>ACCESSORIES FURNISHED</td>
<td>Soft protective pouch</td>
</tr>
</tbody>
</table>
Mic Preamp Gain

Audio Technica AT871UG

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Level at mic</td>
<td>78 dB-SPL</td>
</tr>
<tr>
<td>Mic ref level</td>
<td>94 dB-SPL</td>
</tr>
<tr>
<td>Mic Sensitivity</td>
<td>-33 dBV</td>
</tr>
<tr>
<td>dBV to dBU</td>
<td>2.2</td>
</tr>
<tr>
<td>Output level</td>
<td>0 dBu</td>
</tr>
<tr>
<td>Gain required</td>
<td>-46.8</td>
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Gain (typical, controls full clockwise)

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<td>72 Ω</td>
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</tr>
<tr>
<td>Aux Out</td>
<td>&gt;2 kΩ</td>
<td>870 Ω</td>
<td>870 Ω</td>
<td>+7 dBV</td>
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Equivalent Input Hum and Noise: −124 dBV

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Common Mode Rejection
>80 dB at 1 kHz

Polarity
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Overload and Shorting Protection
Shorting outputs, even for prolonged periods, causes no damage. Microphone inputs are not damaged by signals up to +10 dBV; Auxiliary inputs by signals up to +36 dBV
Avixa

Balancing Audio – Chuck Espinoza
Questions