**Disclaimer**: Here are some common formulas; however this is not an exhaustive list and you may not need all of them.

### Video Camera Image Size

\[ IS = 2 \times D \times \tan \left( \frac{A}{2} \right) \]

Where \( IS \) is the image size,
\( D \) is the distance from the lens to the subject,
\( A \) is the lens angle of view.

### Projector Lumens Output

\[ \text{Brightness} = \frac{(L \times C \times A)}{Sg \times Dr} \]

Where \( L \) is ambient light at screen location\(^*\)
\( C \) is the desired contrast ratio
- 7:1 – Passive Viewing – Television
- 15:1 – Basic Decision Making Presentations
- 50:1 – Analytical Decision Making – Art work, Medical
- 80:1 – Full Motion Video – Home Theater
\( A \) is the area of screen **
\( Sg \) is the gain of the screen. Assume a screen gain of 1 unless otherwise noted.
\( Dr \) is the projector derating value. Assume a derating value of 0.75 unless otherwise noted.

\(^*\) Light units are in either lux or footcandles
\(^*\) area in square meters or square feet

### Loudspeaker Coverage Pattern (Ceiling Mounted)

\[ D = 2 \times (H - h) \times \tan \left( \frac{C_z}{2} \right) \]

Where \( D \) is diameter of coverage circle at ear height
\( H \) is overall ceiling height
\( h \) is height of the listener’s ears (48 inches)
\( C_z \) is off-axis coverage angle of polar pattern

### Loudspeaker Spacing (Ceiling Mounted)

\[ D = 2 \times r \quad \text{(Edge-to-edge)} \]
\[ D = r \times \sqrt{2} \quad \text{(Minimum overlap)} \]
\[ D = r \quad \text{(Center-to-center)} \]

Where \( D \) is the distance between loudspeakers
\( r \) is the radius of loudspeaker coverage circle

### Wattage at the Loudspeaker

\[ EPR = 10^\left( \frac{L_p + H - L_s + 20 \log \left( \frac{D_2}{D_r} \right)}{10} \right) \times W_{ref} \]

Where \( EPR \) is electrical power required at loudspeaker
\( L_p \) is SPL required at distance \( D_2 \)
\( H \) is required headroom
\( L_s \) is loudspeaker sensitivity at 3.28 feet (1 m)
\( D_2 \) is distance from loudspeaker to listener
\( D_r \) is distance reference value
\( W_{ref} \) is the wattage reference value. Assume a wattage reference value of 1 unless otherwise noted.
**Parallel Loudspeaker Impedance**

\[ Z_T = \frac{1}{\frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3} \ldots \frac{1}{Z_N}} \]

\[ Z_T = \frac{Z_1}{N} \]

Where \( Z_T \) is the total impedance of the loudspeaker system,
\( Z_1 \) is the measured impedance of a loudspeaker,
\( N \) is the quantity of loudspeakers in the circuit.

**Ohm’s Law Related**

\[ I = \frac{P}{V} \]

Where \( I \) is current,
\( V \) is circuit voltage,
\( P \) is power.

* Look up amplifier power in owner’s manual before adding to the other AV devices.

**Needed Acoustic Gain**

\[ NAG = 20 \log \left( \frac{D_0}{EAD} \right) \]

Where \( NAG \) is Needed Acoustic Gain,
\( D_0 \) is distance from source to listener,
\( EAD \) is Equivalent Acoustic Distance.

**Potential Acoustic Gain**

\[ PAG = 20 \log \left( \frac{D_0 \cdot D_1}{D_2 \cdot D_S} \right) \]

Where \( PAG \) is Potential Acoustic Gain,
\( D_0 \) is distance from source to listener,
\( D_1 \) is distance from loudspeaker to microphone,
\( D_2 \) is distance from loudspeaker to listener,
\( D_S \) is distance from source to microphone.

**Audio System Stability (PAG NAG Complete Formula)**

\[ 20 \log_{10} \left( \frac{D_0}{EAD} \right) < 20 \log_{10} \left( \frac{D_0 D_1}{D_2 D_S} \right) - 10 \log_{10}(NOM) - FSM \]

Where \( NOM \) = Number of Open Microphones,
\( FSM \) = Feedback Stability Margin,
\( EAD \) = Equivalent Acoustic Distance,
\( D_0 \) = the distance between the talker and the farthest listener,
\( D_1 \) = the distance between the closest loudspeaker to microphone and the microphone,
\( D_2 \) = the distance between the closest loudspeaker to the listener and the farthest listener,
\( D_S \) = the distance between the sound source (talker) and the microphone.

**Power Amplifier Wattage (Constant Voltage)**

\[ W_t = W \ast N \ast 1.5 \]

Where \( W_t \) is required wattage,
\( W \) is watt tap used at individual loudspeaker,
\( N \) is total number of loudspeakers,
1.5 is 50 percent amplifier headroom.

**Power Amplifier Heat Load**

\[ Total \ BTU = W \ast 3.4 \ast (1 - E_D) \]

Where \( Total \ BTU \) is the total British Thermal Units released,
\( W \) is the wattage of the amplifier,
\( E_D \) is the efficiency of the device.
<table>
<thead>
<tr>
<th>Heat Load</th>
<th>Jam Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ Total \ BTU = W_E \times 3.4 ] [ JAM = \frac{ID}{\left(\frac{OD_1 + OD_2 + OD_3}{3}\right)} ]</td>
<td></td>
</tr>
<tr>
<td>Where Total BTU is the total British Thermal Units released [ W_E ] is the total watts of equipment in the room</td>
<td></td>
</tr>
<tr>
<td>Where ID is the inner diameter of the conduit [ OD ] is the outer diameter of each conductor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conduit Capacity</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>[ ID &gt; \frac{OD^2}{0.53} ] [ ID &gt; \frac{OD^2 + OD^2}{0.31} ] [ ID &gt; \frac{OD^2 + OD^2 + OD^2}{0.40} ]</td>
<td></td>
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<tr>
<td>One Cable [ Two Cables ] [ 3+ Cables ]</td>
<td></td>
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<tr>
<td>Where [ ID ] is the inner diameter of the conduit [ OD ] is outer diameter of each conductor</td>
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<tr>
<th>Computer Video Signal Bandwidth</th>
<th>Minimum Video System Bandwidth</th>
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<tbody>
<tr>
<td>[ HF = \frac{H_{pix} \times V_{pix} \times f_v}{2} \times 3 ] [ SF = HF \times 2 ]</td>
<td></td>
</tr>
<tr>
<td>Where [ HF ] is the highest frequency in Hertz [ H_{pix} ] is the total number of horizontal pixels [ V_{pix} ] is the total number of vertical pixels [ f_v ] is the refresh rate</td>
<td></td>
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<tr>
<td>Where [ SF ] is the system frequency in Hertz [ HF ] is the highest frequency in Hertz of the computer signal</td>
<td></td>
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<tr>
<th>Digital Video Data Rate</th>
<th>Minimum Task Lighting</th>
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<tr>
<td>[ R = H_{pix} \times V_{pix} \times C \times 1.25 \times FPS \times 3 ] [ Light_{Min} = \frac{\left(\frac{L_P}{A}\right)}{3} ]</td>
<td></td>
</tr>
<tr>
<td>Where [ R ] is the data rate in bits per second [ H_{pix} ] is the total number of horizontal pixels [ V_{pix} ] is the total number of vertical pixels [ C ] is the color depth (bit depth) in bits [ FPS ] is the number of frames per second</td>
<td></td>
</tr>
<tr>
<td>Where [ Light_{Min} ] is the minimum task lighting in Lux [ L_P ] is projector lumens [ A ] is the area of the screen in meters squared</td>
<td></td>
</tr>
</tbody>
</table>

*Assume unity gain unless otherwise directed.*