### Master List of Formulas and Symbology Descriptions

**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, and \( A \) is the lens angle of view.

#### Projector Lumens Output

\[ Brightness = \frac{\left( L \times C \times A \right)}{Sg} \times \frac{1}{Dr} \]

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, and \( Dr \) 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)

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

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), \( C_\angle \) 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, and \( W_{ref} \) is the wattage reference value. Assume a wattage reference value of 1 unless otherwise noted.
### Loudspeaker Impedance

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

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)

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

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 the microphone and the microphone.
- \( D_2 \) = the distance between the loudspeaker closest to the farthest listener and the farthest listener.
- \( D_S \) = the distance between the sound source (talker) and the microphone.

### Power Amplifier Wattage (Constant Voltage)

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

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

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

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.
### Heat Load

\[ Total \ BTU = W_E \times 3.4 \]

Where Total BTU is the total British Thermal Units released

\[ W_E \] is the total watts of equipment in the room

### Jam Ratio

\[ JAM = \frac{ID}{\left(\frac{OD_1 + OD_2 + OD_3}{3}\right)} \]

Where ID is the inner diameter of the conduit

OD is the outer diameter of each conductor

### Conduit Capacity

Where ID is the inner diameter of the conduit

OD is outer diameter of each conductor

\[ ID > \sqrt{\frac{OD^2}{0.53}} \quad \text{One Cable} \]

\[ ID > \sqrt{\frac{OD^2 + OD^2}{0.31}} \quad \text{Two Cables} \]

\[ ID > \sqrt{\frac{OD^2 + OD^2 + OD^2}{0.40}} \quad 3+ \text{Cables} \]

### Image Height to Farthest Viewer Distance Ratio

The relationship between image height, viewing task, and farthest viewer distance can also be represented as a wheel:

\[ \frac{IH}{ID} = \frac{DT}{VT} \]

Where \( IH \) = Image height

\( ID \) = Distance from the farthest viewer to the image

\( VT \) = Viewing Task Ratio: distance

4 for Inspection Viewing Tasks

6 for Reading with Clues Viewing Tasks

8 for General Viewing Tasks

\( DT \) = Viewing task: height ratio. This will be 1.

### Computer Video Signal Bandwidth

\[ HF = \frac{H_{pix} \times V_{pix} \times f_v}{2} \times 3 \]

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

### Minimum Video System Bandwidth

\[ SF = HF \times 2 \]

Where SF is the system frequency in Hertz

\( HF \) is the highest frequency in Hertz of the computer signal