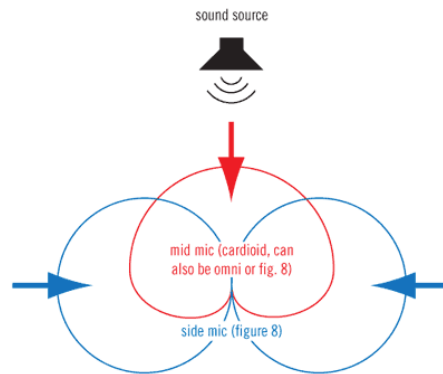


M-S Stereo Matrix Explained

Andrew Garrison, University of Texas at Austin, updated 11/2016.

The “M-S” of M-S stereo stands for “Mid-Side.” It refers to the fact that you are recording the Mid area with a cardioid or hypercardioid microphone and you are recording the Sides with a single Figure-of-8 (bi-directional) microphone. By passing these two mono signals through a simple matrix, you can turn these two mono signals into one stereo track. M-S has long been in use in Europe and it is being used more and more in the U.S.



The beauty of M-S recording is that, in post, you can use it as a clean mono recording without phasing issues, or it can be a stereo signal with a stereo image you can adjust to be wider or narrower AFTER the recording.

Set-up for production can be two microphones, such as an AT4051 for the Mid mic and an AKG 414 for the Side mic, as seen in this picture:



You can also use a single body mic like the Audio Technica BP4029 that has both a bidirectional capsule and a hypercardioid capsule in the same body. In this way you can use this mic on a boom to record dialog using the mid (hypercardioid) mic, but also use the same mic to record stereo in a location, for example for ambiances.

The Matrix

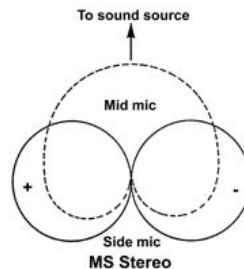
The M-S encoding matrix is based on this clever idea. We get the Left side by adding the Mid (Cardioid signal) to the Bi-directional mic signal, and we get the Right side by adding the Mid signal to the *Phase Inverted* Bi-directional signal.

Phase inversion is what happens when we literally flip the signal upside-down in Pro Tools or another Digital Audio Workstation. All the peaks become troughs in the inverted track, and all the troughs are now peaks. You can also change the phase by 180 degrees by the original recorded track out to a new track to record, through a XLR cable that has pins 2 and 3 switched on one connector.

The phased-inverted or phase-reversed signal is 180 degrees out of phase from the original signal. If the two signals are combined into a single mono channel, every peak of energy in the original signal would be matched by the inverted signal's trough, so the waveform coming out of the summed signal would be flat—no sound at all. But we are not summing these together. We are summing the original signal to the mid microphone signal to make the Left side, and we are summing the phase inverted signal to the same original signal to create the Right side.

LEFT Channel = M+S ["S" is the original bidirectional signal.]

RIGHT Channel = M+(-S) ["-S" is the phase inverted bidirectional mic signal.]



MATRIXING M-S in Pro Tools

If you recorded MS stereo as two separate mono tracks, you need to create a little matrix so that they become one single stereo track. This is easy to do in Pro Tools.

1. The file for the cardioid or hypercardioid mic pointing forward--the "**Mid**" mic--goes into its own mono track, panned to the center (L and R).
2. The file for the "**Side**" microphone, the Bi-Directional (figure-of-eight) mic, goes into a second mono track. Pan this all the way to the Left.
3. Duplicate the **Side** mic track or enter it again into a third track and invert the phase. into another track and then duplicate that track to a third track. This means literally flipping the wave so that all the peaks are troughs, and vice-versa. (You can do this using Audio Suite. Choose the Other>Invert and then render.) Now pan this inverted track all the way to the Right.

4. When you play this back through stereo speakers you will hear stereo. You can vary how wide the stereo image is by changing the gain between the two SIDE tracks and the Mid track. Bounce all those tracks out to a single stereo track or send them as aux signals to another, Stereo Record Track in Pro Tools and record.

DE-MATRIXING M-S in Pro Tools

The 4029 and some other M-S microphones permit you to switch between recording two M and S mono signals to one, stereo, already-matrixed, signal. On the 4029 you can switch between a wide or narrow stereo pattern.

If, later, you want to change the width of the stereo image or get back to just the signal from the Mid mic, you can DE-matrix the MS stereo. Do this by summing the stereo Left side with the stereo Right side into a single mono channel, and reducing the gain by half.

The math is simple.

$$\begin{aligned}L+R &= 2M \\ \text{or} \\ L+R &= (M + S) + (M - S) = 2M\end{aligned}$$

Want just the bi-directional mic information from an M-S stereo signal? Subtract the right from the left, that is, invert the Right signal and sum it with the left. You will get the Side signal at twice its gain. The formula looks like this:

$$\begin{aligned}L-R &= 2S \\ \text{or} \\ L-R &= (M + S) - (M - S) = 2S\end{aligned}$$

In other words, for the original MID [hypercardioid] signal from the front:

1. Place your MS stereo into a stereo track in Pro Tools
2. Split the stereo track into two mono tracks, Left and Right.
3. Send the Left track to a single, mono Aux track that is panned to the center.
4. Send the Right track to the same single, mono Aux track.
5. Decrease that Aux track's output by 6dB

Bounce that Stereo track out to disk as a mono file, or send it to a record track and you will have a mono audio file of only the Mid microphone.