Small MRI 3-Axes Gradient Coils

All models feature active shielding and B_0 eddy current compensation.

✓Maximum Sample Volume ✓Low Noise and Vibration ✓High Continuous Gradients

Advances in hardware for magnetic resonance imaging (MRI) are needed to improve image quality, ease of use, and functionality in high-field MRI research using small-animal models. Doty's MRI gradient coils fill this need.

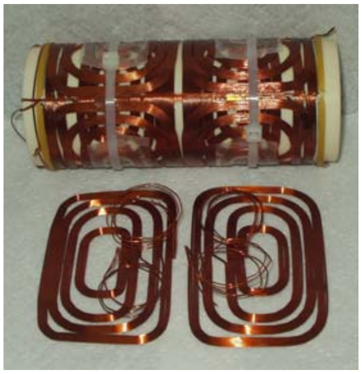
Low-amplitude B_0 eddies are induced in the magnet radiation shields primarily from minute variations in coil diameters along the axis or from axial registration errors between the gradient and shield coils. Our use of alumina ceramic for both the gradient and shield formers allows higher precision to be maintained, and low-amplitude eddy current to be minimal. Ceramic coil forms, together with heavy Golay windings dramatically reduce vibration and noise, even at the highest fields.

Any remaining B_0 eddy is compensated by a time-dependent correction applied to a B_0 shim coil. Another advantage of the alumina coil form is its very high thermal conductivity, which helps equilibrate hot spots. The cooling requirements are then satisfied with relatively minor constraints on the winding geometry.

Higher-order eddies are minimized by active shielding. Our coil designs often achieve a factor of 2 better shielding of the transverse gradients than alternative designs.

There is a strong benefit from gradient coil construction with an alumina ceramic coilform and multilayer windings. We significantly reduce acoustic noise, vibration, and recovery time, compared to gradient coils from other microscopy MR vendors.

Parameter	Model 16-39	Model 26-40	Units
Cooling method	water	water	
diameter *(d_i)* for 4% local deviation	5	14	mm
length *(z_i)* for 4% local deviation	12	17	mm
diameter *(d_i)* for 10% local deviation	7	18	mm
length *(z_i)* for 10% local deviation	17	22	mm
Nearest Gradient Null point	9.2	15.4	mm
Outside diameter, d_O	39.0	39.6	mm
Coil half-length, h_1	36	36.1	mm
RF shield diameter, d_S	16	26	mm
Clear bore, d_i	14	23.6	mm
Max inductance, L	86	37	μH
Max DC resistance, R_E	1.5	1.4	Ω
Min gradient gain, α	200	48	mT/Am
Max shielding error at 1.5 d_0	0.5	0.4	%
Min slew rate, $G_S=\alpha V/L$, at 1 V	2800	1,189	T/m/s
Continuous current, I_{RMS}	10	11	A
Continuous gradient, G_C	200	**53**	**G/cm**
Peak Voltage	120	120	V
Approx. EPI Acoustic Noise, 7 T	70	70	dBa
Rise time to G_C for 100 V	9	4.6	μs
Total mass	0.5	0.4	kg



gradients partially assembled

Local deviation (or differential linearity) is defined as the rms deviation from the mean gradient over the specified diameter, d_i, and length, z_i, of the cylindrical sample region. The half-length h_1 is the distance from the center to the closer of the two external end surfaces. Eddy currents from the internal RF shield are negligible. The gradient slew rate G_S is the instantaneous rate of change in gradient when a 1 V step is applied. The continuous current ratings are *true* continuous ratings for a single axis with no time limit and adequate cooling. Derate the current 30% when all three axes are driven simultaneously.