9180 Series Gradient Amplifiers

Description

These power amplifiers are designed specifically for use as high performance, high bandwidth, low noise gradient amplifiers in NMR and MRI applications.

Performance and design are tailored to the unique output waveform and load impedances seen in these applications.

The output stage is a linear amplifier bridge using mosfets. The power supply to the output stage is switched between two voltage levels depending on the load and output demand. This configuration gives some advantages over a switch-mode design in research applications – lower output noise levels, wider bandwidth, superior transient response, and freedom from uncertainty in the start point of a rising edge – while the 2 stage power supply gives the design competitive power efficiency. Power supply voltage levels can be changed to match a specific load resistance and inductance/rise time requirements.

Specification

Output

Peak Current:	180A
Peak Voltage:	170V
RMS Current Output:	45A
Small signal current source bandwidth:	40kHz
RMS noise current 20Hz-30kHz typ:	230µA

Control

- Current Demand: Differential analogue input.
- Digital control of on/standby state.
- Digital reporting of amplifier status over RS232 link and parallel optical isolators.

Front panel

- LEDs show amplifier status.
- Switches put amplifier into run or standby states, remote or local control.

AC power and mechanical

- 380V/400V/415V, 6A, 3 phase, no neutral connection, or
- 208V, 12A, 3 phase, no neutral connection.
- 19" rack mount. 6U – 266mm high. Depth behind front panel mounting surface 500mm
- Weight: 60kg
- Cooling: Forced air. Air flow from front to back. Fans are rear mounted.

Advantages in NMR/MRI applications

- Amplifier delivers the demanded output current independent of eddy currents in the gradient coil set.
  This makes it considerably easier to set up the required eddy current correction terms accurately. You are correcting for the gradient coil set and magnet eddy currents only, and not attempting to correct for the amplifier response at the same time.
- Current rise is linear and under control. The amplifier includes a precision slew rate limiter in the input signal conditioning path and does not rely on driving its output to the output voltage limits.
- For flat topped pulses the integral of output current is proportional to the peak value.
- Very fast settling time and minimal over/under shoot on the flat top and at zero.
- Rise time is independent of gradient coil resistance.
- Wideband flat frequency response.
- Low output ripple and noise.
- Comprehensive fault protection.

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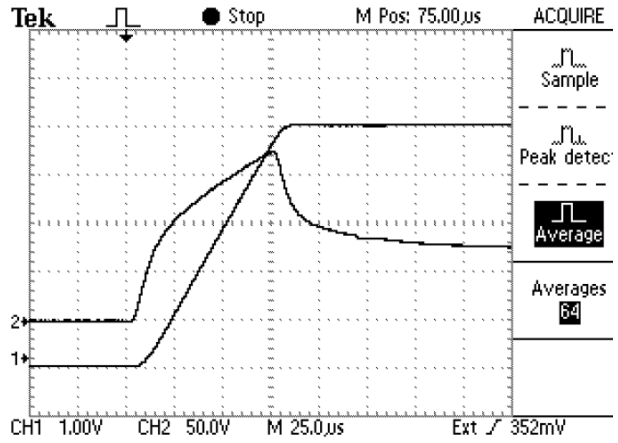
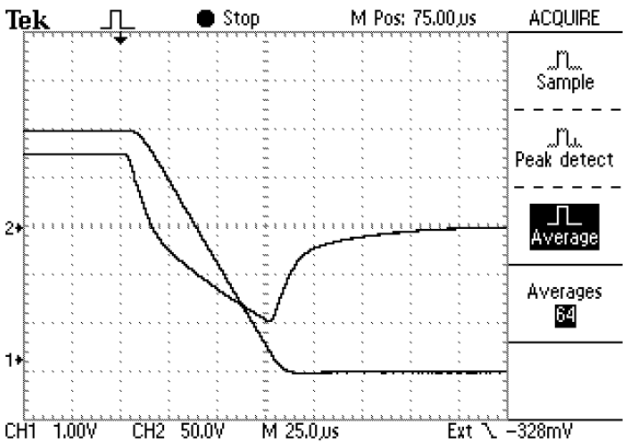
Performance

These plots show the measured performance in a benchtop MRI application.

Flat top pulse response

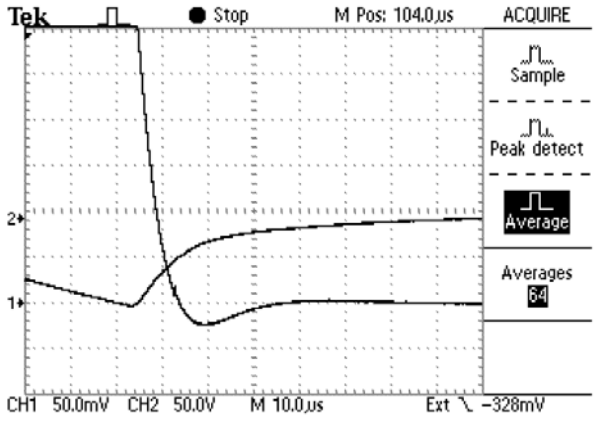
Showing rising and falling edges of a 100A flat topped pulse. 25µs per division.
CH1: Output current 20A/Div
CH2: Output voltage.





Showing under-shoot at end of fall to 0A from 100A. 100µs rise time. 10µs per division.
CH1: Output current 1A/Div End of fall to 0A.
CH2: Output Voltage

Current undershoot is less than 0.5% of peak current.



Small signal frequency response

Showing the gain (in black) and phase (in red) response

3dB bandwidth is 40kHz. Gain plot is 10db per division.