Electroporation

Gene Pulser II System

E. coli Pulser Apparatus

Electroporation Accessories

Electroprotocols Online

Gene Pulser II System

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- **Specifications**

The expertise that made the original Gene Pulser apparatus and accessory modules the most popular electroporation system available has been applied in the Gene Pulser II system, featuring unique PulseTrac circuitry. The modular design of the Gene Pulser II system has the dual advantages of using the accessory that has the widest range of settings to target specific cell types and offering the flexibility of purchasing the highest quality equipment for consistent protocol reproduction. The PulseTrac diagnostic algorithm of the Gene Pulser II system minimizes variation between experiments and delivers consistent electroporation over the lifetime of the unit. With the Gene Pulser II system, the electrical variables are controlled with exacting precision so that your results reflect only the biological variables in your experimental design. See bulletins 1926 and 2076 for details.

Continuous Innovation with Flexwave Technology

Bio-Rad's gene transfer program has delivered essential technology to the life science community since Bio-Rad pioneered electroporation technology with the introduction of the Gene Pulser apparatus in 1986. High efficiency bacterial electroporation became a reality in 1987 with the introduction of the Pulse Controller and the 0.2 cm cuvette. The patented E. coli Electroprotocols followed in 1988. (26, 27) In 1990, the 0.1 cm cuvette design boosted prokaryotic applications and efficiencies even further. The advanced features of the RF Gene Pulser II module open new doors in gene transfer innovation with Flexwave technology.

Reliable Performance

The Gene Pulser II apparatus works with any of five accessory modules for high efficiency, reproducible electroporation of virtually any cell type. The PulseTrac circuitry works by continuously monitoring all aspects of the pulse circuit, including the resistance of the sample, and instantly adjusts to any variation, to consistently deliver the exact pulse expected. In addition, the Gene Pulser II system is the only electroporation device that accurately reports the actual time constant of every pulse, so that your protocols can be reproduced precisely and reliably.

New RF (Radio Frequency) Electroporation with Flexwave Technology

The RF Gene Pulser module works with the Gene Pulser II main unit to electroporate samples using radio frequency waveforms. The PulseTrac circuitry of the Gene Pulser II main unit combines with the power and programmability of the RF module to deliver patented pulse output we call Flexwave technology. This maintains higher cell viability for mammalian cell transformation.

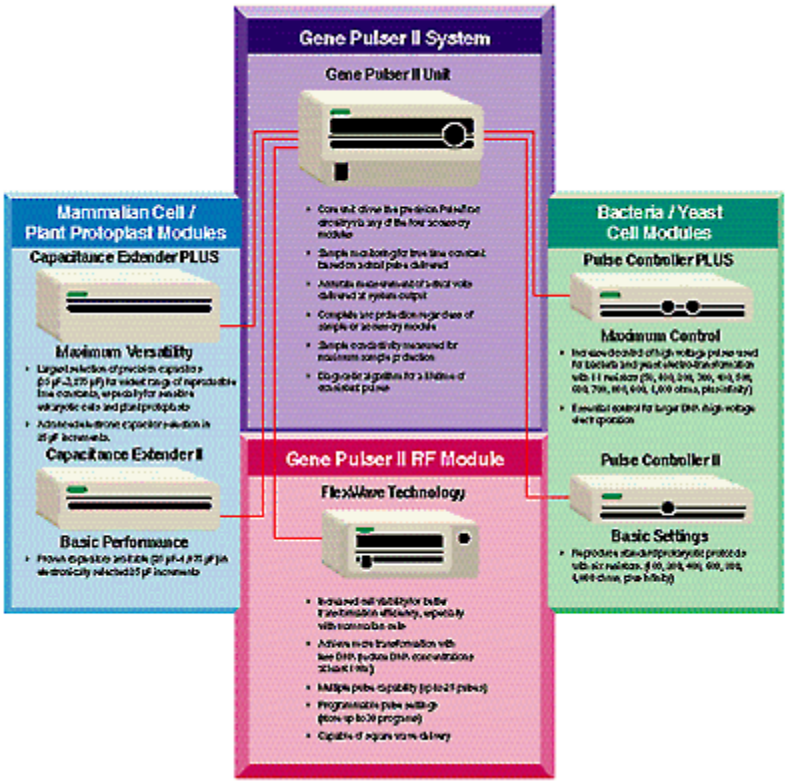
RF Optimization

Each pulse can be designed to contain multiple bursts of energy (up to 25 pulse bursts that have a DC base). The peak voltage for each burst is set, as well as the percent modulation which directly influences the sinusoidal wave height within each pulse burst. The number of oscillations within each burst is determined by the frequency. The number and duration of each burst can also be set, as well as the interval between bursts. All this, with a programmability function, delivers many advantages

over conventional electroporation. Square waves are also possible, making this the most versatile electroporation system available.

Choose Dedicated Components for Reproducible Results

The Gene Pulser II unit is the core that drives the precision PulseTrac system. It can be linked to any of the five accessory modules, depending on the biological application and pulse flexibility required. The PLUS modules provide the widest range of settings to improve efficiencies or target new cell types. For bacterial or yeast transformation, choose the advanced Pulse Controller PLUS module to deliver DNA or proteins of any size or complexity into cells with maximum sample protection. Target mammalian cell, embryo, or plant protoplast electroporation with the widest range of precision capacitors available (up to 3,275 µF) in the versatile Capacitance Extender PLUS module. Transform the most sensitive eukaryotic cells or accommodate larger cell mass with lower voltage pulses using these larger capacitors. The Pulse Controller II offers the standard resistor settings to reproduce established bacterial or yeast protocols. The Capacitance Extender II module provides the capacitor range to perform proven mammalian cell Electroprotocols. The RF module delivers the most flexible waveform ever for improved cell viability and more efficient electroporation.



Advanced Features

GREATER VERSATILITY

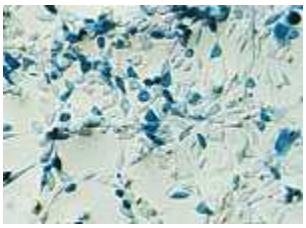
- Target optimal pulse parameters for bacterial and yeast protocols with a wider range of high voltage capacitors (1.0 to 50 µF) in the Gene Pulser II unit. Link these precision capacitors to a wider range of parallel resistors for maximum sample protection.
- Electroporation of a wider variety of mammalian cell types with precision electronic capacitor selection in 25 µF increments (up to 3,275 µF) and with voltage selection in 2 V increments that operates at a higher voltage maximum (up to 500 V).

RELIABLE CIRCUITRY

- Pulse parameters can be accurately reproduced. The PulseTrac circuitry measures and automatically displays tau for every pulse, based on the actual voltage delivered to the cuvette sample (including sample resistance). You are given precision pulse feedback information that is

mandatory for protocol reproduction.

- Avoid losing precious samples to inappropriate pulses by verifying biological sample resistance in the cuvette before the pulse
- Complete system arc protection is linked to precision PulseTrac output regardless of the module or sample used
- Error free assembly, as each module uses unique cable connectors that are keyed to fit the Gene Pulser II unit only in the proper orientation



Evaluation of electroporation efficiency using a
beta-galactosidase expression vector in NIH 3T3 cells.
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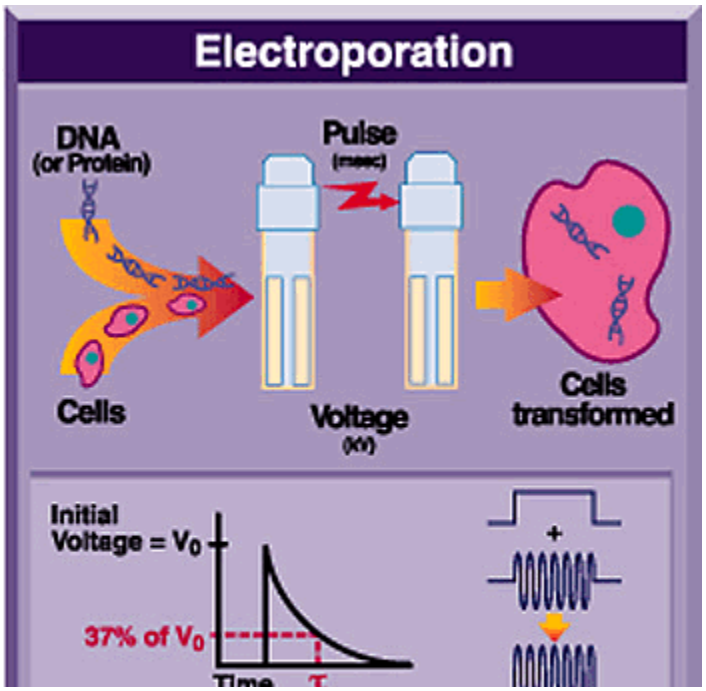
ULTIMATE SAFETY

- PulseTrac circuitry (IEC 1010 approved) automatically diverts voltage to ground whenever the pulse is interrupted
- Stronger cable connectors for increased protection during high voltage pulse delivery



Use either traditional exponential decay or RF technology to efficiently transform a range
of cells. The Flexware technology of the RF module delivers the unique combination of a
pulse of radio frequency (sinusoidal) waveform in combination with a DC base pulse.

THE FUTURE IS NOW

- Your link to future technology is already part of the Gene Pulser II system. Connect the new RF module for more versatile waveforms via the two-way communication port on the back of the Gene Pulser II unit. Flexwave technology is not only adaptable to more cell types, the module is also programmable for ease of use and requires less DNA for transformation of mammalian cell lines.

The Exponential Decay Pulse

The exponential pulses delivered by the Gene Pulser II system or E. coli Pulser unit are instantly released from the selected capacitor and decay rapidly (exponentially) over time (msec). The delivered pulse is characterized by two pulse parameters, the field strength (kV/cm) and the time constant (tau). You control the field strength by setting the voltage (kV) that is pulsed across the cuvette gap (cm). The time constant is determined by the resistance and capacitance in the complete circuit. Reproducible pulse delivery is assured with either the Gene Pulser II system or the E. coli Pulser unit, as the complete pulse circuit is accurately monitored and the true sample time constant is displayed. In addition, actual volts delivered can be verified for consistent protocol reproduction. The Gene Pulser II system has the added capability to verify critical sample resistance before the pulse.

Key Optimization Concepts

Electroporation must be optimized for each cell type, since the pulse must penetrate cells that differ in diameter, in membrane/cell wall composition, and in the medium needed to support membrane/cell wall integrity during electroporation. Key parameters for optimal exponential decay electroporation are

- The time constant (tau), is an essential parameter because it precisely describes each pulse delivered to the sample. Tau is the amount of time it takes for the initial peak

voltage (V_0) to drop to the value of V_0/e; about 37% of V_0.

- The field strength (E) applied to the sample is the initial voltage (V_0) set and delivered across the distance (cm) between the electrodes in the cuvette (E= kV/cm).

Both the Gene Pulser II apparatus and the E. coli Pulser unit automatically measure tau and the actual peak voltage delivered to the cell sample for each exponential decay pulse, and display them as easy-to-read LED values. This allows you to monitor and reproduce the time constants and the field strengths reported by other laboratories for optimal electro-transformation.

Protocols and References

Benefit from Bio-Rad's long-standing electroporation leadership by receiving the latest electroporation protocols developed by scientists in independent laboratories and by Bio-Rad's electroporation research specialists. Technical bulletins describing methods for electroporating a variety of prokarayotic and eukaryotic cell types are available. In addition, the Gene Pulser Electroprotocols collection (catalog number 165-2094) provides access to electroporation protocols from scientists world-wide who use the Gene Pulser system in their research. Our extensive list of references documenting methods for the electroporation of both prokaryotic and eukaryotic cells can assist you in easily opitimizing electroporation for your research. Contact your Bio-Rad office for information on the optimal electroporation conditions for your individual research needs.

Gene Pulser II System

GENE PULSER II APPARATUS

Input voltage	100/120 V RMS, 50/60 Hz 220/240 V RMS, 50/60 Hz
Input current	15 amp RMS in-rush. Operating at <1.6 A at 110/120 V and <1.0 A at 220/240 V
Maximum output voltage and current	2,500 V at 125 amp peak (normal load); limited to 1,500 A during arc
Output waveform	PulseTrac exponential decay with RC time constant dependent on sample and capacitor selected
Output voltage adjustment	50–2,500 V range (depending on the capacitor) with 10 V adjustment precision for the high voltage range and 2 V for the low voltage range (50–500 V)
Ambient operating environment	Temperature 0–5 °C; Humidity 0–95% without condensation
Regulatory	Passes requirements of IEC 1010. In addition, the system passes requirements for FCC, Class A.
Dimensions	34 x 31 x 19 cm (L x W x H)
Weight	10.41 kg

RF MODULE

Input voltage	100/120 V RMS, 50/60 Hz 220/240 V RMS, 50/60 Hz
Maximum input current (in–rush)	15 amp RMS
Maximum output voltage and current	400 V at 6 amp peak (normal load); limited to 6 A during arc
Output waveform	Combination of sine wave with constant DC level, user adjustable
Ambient operating environment	Temperature 0–35 °C Humidity 0–95% without condensation
Regulatory	Passes requirements of EN61010. In addition, the system passes requirements for FCC, Class A.
Dimensions	24 x 31 x 9.7 cm (L x W x H)
Weight	3.7 kg

PULSE CONTROLLER II

Selectable resistance, ohms (parallel)	100, 200, 400, 600, 800, 1,000, infinity ohms, measured with Gene Pulser II apparatus
Dimensions	23 x 31 x 7.7 cm (L x W x H)
Weight	1.7 kg

PULSE CONTROLLER PLUS

Selectable resistance, ohms (parallel)	50, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000, infinity ohms, measured with Gene Pulser II apparatus
Dimensions	23 x 31 x 7.7 cm (L x W x H)
Weight	1.87 kg

CAPACITANCE EXTENDER II

Selectable capacitors, µF	25 to 1,075 µF in 25 µF increments, measured with Gene Pulser II apparatus
Dimensions	23 x 31 x 9.7 cm (L x W x H)
Weight	2.57 kg

CAPACITANCE EXTENDER PLUS

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Ordering Information To order now...

Catalog No.	Description
Gene Pulser Systems	
165-2105	**Gene Pulser II Apparatus**, 100/120 V, 50/60 Hz, includes shocking chamber, 15 sterile sample cuvettes (five 0.1 cm gap, five 0.2 cm gap and five 0.4 cm gap), cuvette rack
165-2107	**Capacitance Extender II**, 25-1,075 µF range controlled by Gene Pulser II apparatus, includes integrated leads
165-2109	**Pulse Controller II**, 100-1,000 ohm range, seven settings (100, 200, 400, 600, 800, 1,000, infinite ohms), includes integrated leads
165-2112	**Gene Pulser II RF Module**, 100/120 V, 50/60 Hz, uncludes 9-pin cable to connect to Gene Pulser II apparatus
165-2094	**Gene Pulser Electroprotocols**, includes more than 200 protocols describing equipment settings and cell handling methods to optimize electroporation applications
165-2106	**Gene Pulser II Apparatus**, 220/240 V, 50/60 Hz
165-2108	**Capacitance Extender PLUS**, 25-3,275 µF range controlled by Gene Pulser II apparatus, includes integrated leads
165-2110	**Pulse Controller PLUS**, 50-1,000 ohm range, twelve settings (50, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000, infinite ohms), includes integrated leads
165-2113	**Gene Pulser II RF Module**, 220/240 V
Cuvettes	
165-2086	**Gene Pulser/E.coli Pulser Cuvettes**, 0.2 cm electrode gap, 50, sterile
165-2088	**Gene Pulser /E.coli Pulser™Cuvettes,**, 0.4 cm electrode gap, 50, sterile
165-2089	**Gene Pulser/E.coli Pulser Cuvettes**, 0.1 cm electrode gap, 50, sterile
Replacement Parts	
165-2095	**Gene Pulser/E. coli Pulser Cuvette Rack**
165-2097	**Gene Pulser I/E. coli Pulser Chamber**
165-2111	**Gene Pulser II Chamber**
165-2099	**Gene Pulser I/E. coli Pulser Chamber Electrode Contacts**, 1 pair