Electroporation & Electrofusion Products

Bacteria & Yeast

Plants & Insects

Mammalian Cell Transfections

In Vitro, In Utero, In Ovo

Electrofusion

Microinjection
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Electroporation

Electroporation is the application of controlled electrical pulses to living cells in order to permeabilize the cell membrane for the purposes of transfection or transformation. These pulses are delivered to a pair of electrodes by a pulse generator. The pulse induces a transmembrane potential which causes the reversible breakdown of the cellular membrane. This action results in the formation of pores that allow molecules, such as DNA, proteins or antibodies, to enter the cell. The process involves two variables, field strength and pulse length. These variables are manipulated in order to maximize the efficiency of gene transfer. A third variable, pulse shape, is dependent upon the type of pulse generator used. In this catalog, we have included an optimization guide to help you achieve the best results.

Due to its ease of use, reproducibility, high efficiency and low toxicity, electroporation has become the method of choice for introducing many types of molecules into cells such as mammalian, bacterial, yeast, plant and insect.

Electrofusion

Electrofusion is characterized by the presence of two membranes, in close contact, that can be joined by the application of a pulsed electrical field. The electrofusion procedures are very similar to those of electroporation. When neighboring cells are brought into contact during electroporation, these cells can be induced to fuse. The key to electrofusion is that the cells must be brought into contact first. This is accomplished by the application of an AC pulse which causes dielectrophoresis resulting in a pearl-chain (dimer) formation. The DC square pulse is then applied resulting in the integration of cell membranes. This is followed by another application of an AC pulse which causes cell compression to stabilize the cell hybrid. This method is especially useful for hybridoma work.

Researchers can also use chemical or manual methods of aligning the cells prior to electrofusion. Though these alternative methods can be time consuming and potentially toxic, they are useful for nuclear transfer and other fusion application.

Microinjection

Microinjection is a well established technique used routinely in animal cells and embryos to insert genetic material such as DNA or RNA directly into a cells cytoplasm or in to the nucleus. Injection of the genetic material is inserted via a needle varying in size from 0.5μM to 20μM in diameter that penetrates the cell membrane and/or the nuclear envelope to deliver the desired amount of molecule. Microinjection is performed, observed and controlled under a microscope.
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NEW! MicroJect 1000
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NEW! BTXpress™ High Performance Electroporation Solution
See page 30-31 for details.

NEW! Petri Dish Platinum Electrode for Tissue Slices
See page 42 for details.
Electroporation has long been recognized as one of the most efficient methods of transforming human genes into prokaryotic cell lines. Researchers use this technique to express recombinant proteins to study gene function and for the therapeutic treatment of human diseases. Typically, the most commonly transformed cell lines are bacteria and yeast, such as Escheria coli, Agrobacterium Tumorfaciens, Pichia Pastoris and Saccharomyces Cerevisiae. Electroporation of these gram-negative bacterial strains can achieve transformation success rates in the range of 1X10^10 transformants/ug DNA. Gram-positive bacteria such as Streptococcus pneumoniae and Lactobacillus strains present more of a challenge in achieving transformation success due to their cell wall composition. Electroporation as a technique is able to achieve exceptional results in gram-positive strains in the range of 1X10^7 transformants/ug DNA.

Other more difficult or less utilized prokaryotic cell lines have also achieved significant positive transformation results with this method. These cell lines include anaerobic bacteria such as Desulfovibrio vulgaris, Dictyostelidia, a celluar slime mold, proprietary modified bacteria lines produced for Biofuels, Mycoplasma, Bacillus genera and parasites such as Leishmania.

Electrical transformation has proven to be highly efficient and easily performed in single cuvettes or multi-well electroporation plates (25 or 96 well options) for greater sample quantities.

High Field Strength

High field strengths (voltage applied between electrode gap measured as kV/cm) are critical to achieve high efficiency transformations in prokaryotic cell lines. The ECM 399 and ECM 630 can attain the optimal voltage ranges up to 2500V to provide field strengths of 12-25kV/cm which are essential for prokaryotic applications.

Optimized Time Constants

The time constant or pulse duration is a crucial factor in achieving high efficiency transformations. In an exponential decay wave pulse generators such as the ECM 399 and the ECM 630 the time constant is determined by the values of the resistance and capacitance (RC) settings in the generator. The ECM 399 has fixed RC values which are pre-optimized to provide the standard time constant range of 5-6 msec for efficient transformation of gram-negative bacteria and yeast. The ECM 630 has adjustable RC settings to span the range of time constants needed for gram-positive bacteria, requiring a range from 5 - 10 msec time constants. Other prokaryotic cell lines need the advantage of adjustable RC values due to the need of even higher ranges of time constants to achieve efficient transformation.

Economical Solution

The ECM 399 provides the voltage range needed to achieve the field strengths of 12-25 kV/cm essential for efficient transformation. The ECM 630 has pre-optimized time constants of 5-6msec in high voltage (HV) to provide field strengths with an accuracy of 5.0% for transformation of gram-positive bacteria. This system offers the best low cost solution for simple transformation needs.

Prokaryotes and Eukaryotes Solution

Labs working with a variety of bacterial and yeast strains often need to transfet mammalian cells as well. This requires more flexibility and control over the electrical parameters such as the voltage range and time constant for successful transfection. The ECM 630 has been found to be efficient and the best instrument for select mammalian cell lines such as mouse stem cells.
Figure 1: Field strength and time constants for gram (-) bacteria in 1 mm gap cuvettes using the ECM 630 and 399 models. Field strengths and time constants remain grouped around discrete values making the ECM 399 and 630 ideal for the lab that is performing simple transformations. The ECM 630 would be a good choice for labs that are currently doing simple transformations now, but plan on working with other cell lines in the future, while the ECM 399 would be ideal for the lab that is only interested in simple transformations of bacteria and yeast where the pulse duration is no longer than 5-6 ms.

Figure 2 and 3: Shows Field Strength and pulse duration values for gram positive bacteria in 1 mm and 2 mm cuvettes. Unlike the gram (-) bacteria the field strengths and time constants are more variable with gram (+). The ECM 630 is flexible and settings can be adjusted for optimizing multiple cell lines.
For many years, Agriculture and Horticulture labs have used electroporation to transform plants in order to generate transgenic crops (GMO). Electroporation offers an alternative method for the delivery of genes directly into plant cells, plant tissues and plant protoplasts. Electrofusion allows for the fusion of plant protoplasts for transgenic modified plant applications.

Transformation of plants can be successfully accomplished without prior removal of the cell wall, allowing for greater genetic manipulation potential of the plant cells. Whether performing a stable transformation to generate crops with better traits, enhance productivity or developing transient transformations for gene expression, electroporation has obtained high efficiencies and cell viabilities. BTX offers protocols for successful transformations of many plant cell lines such as rice, sweet potatoes, wheat, barley, tobacco leaf, cotton and root protoplasts using the ECM 630, ECM 830 and ECM 2001.

There are few techniques available that are powerful enough to transfect insect cells and tissues. Electroporation is one of those methods. It has been widely used for successfully transfecting insect cells, such as Drosophila, Bombyx mori embryos and larval tissues. Using electroporation on insect cells has proven extremely useful for invertebrate genetic manipulation and genome function analysis.

Plants
Electroporation offers an alternative method for the delivery of genes directly into plant cells with out prior removal of the cell walls allowing for greater genetic manipulation potential of plant cells. The stable or transient integration of genes into plant protoplast cells is efficiently performed with high cell viability using the ECM 830 square wave system. It has been reported that wheat, barley leaf, and root protoplasts have been successfully transformed and electroporation parameters optimized using the BTX line of generators. The BTX ECM 630 exponential decay wave system provides a wide scope of voltage settings (10-2500V) resulting in field strengths up to 25K/cm and an array of possible time constants (pulse durations) critical for highly efficient electro-transformations. The ECM 630 system enables transformation of Agrobacterium for gene transfer with efficiencies of 1x10^8 transformants/ug DNA.

Field Strengths and Time Constants
The ECM 630 exponential decay wave pulse generator has the voltage range needed to reach the high field strengths (kV/cm) these cells require. The adjustable resistance and capacitance combinations create a wide range of time constant options to ensure efficient transformation of difficult cell types including plant tissues and Agrobacterium cells producing efficiencies of 1 x 10^8 pfu/ugs.

Powerful Exponential Decay Wave Pulse
The diverse combination of settings joined with the power of the exponential decay wave pulse generator provides the permeation of cell membrane for efficient transformation of Drosophila, SF9 cells, and many other insect cells.

Square Wave Gentle Strength
Transformation of plant protoplasts, insect embryos and various tissues including delicate brain tissues require the gentle strength of the square wave pulse generator, the ECM 830. The square wave pulse generator provides the voltage ranges and multiple pulsing capabilities needed for efficient membrane permeation with out sacrificing cell viability critical to these applications.

Protoplast Fusion
Plant protoplast fusion is used to generate genetically modified hybrids to improve traits or enhance production. The use of electrofusion allows for fusion of plant protoplast and the transfer of genes more effectively compared to standard cDNA transformations. The ECM 2001 system is a multi-purpose system for both electrofusion and electroporation. It employs both AC and DC wave forms to align cells for better membrane contact, fuses cells together and with post AC alignment continues to maintain compression of cells during the rounding off period. The span of voltages, pulse lengths and multiple pulsing up to 9 pulses, allow this system to function solely as an electroporator for plant protoplast and mammalian cell transfections.

Insects
Electroporation has been widely used for successfully transfecting insect cells and tissues. Jean-Luc Thomas et al. 2003, found that working with a BTX ECM 830 square wave generator to transfet Bombyx mori embryos and larval tissue was efficient, simple and reliable. The BTX generators can be used with our specialty electrodes for tissue specific transfection in insects or BTX microslides can be utilized for the transformation of large numbers of insect eggs.

References
The ECM 830 is a highly flexible square wave electroporation generator that may be used for in vitro and in vivo transfections and plant transformations.

ECM® 830
Square Wave Electroporation System
See page 22 for details.

The ECM 2001 is a multifunctional square wave electro cell fusion and electroporation generator capable of AC/DC wave pulses. The CE/ETL marked ECM 2001 is used for a variety of applications from embryo manipulation to Hybridoma production to plant tissue transformation.

ECM® 2001
Square Wave Electrofusion Electroporation System
See page 23 for details.

Electroporation of anthers (top row) prior to their culture induces faster growth (c), somatic embryo formation (e) and, ultimately, haploid plant regeneration (g), as shown here for field pea.

Mammalian Cell Transfections – “The Advantage”

The advantage of the square wave lies in its superior ability to introduce genes, proteins and other molecules into mammalian cells efficiently. Mammalian cells respond exceptionally better to the gentle strength of the square wave pulse to allow for both high transfection efficiency while maintaining cell viability. With the ECM 830, users have control over their parameters, including voltage, pulse length, number of pulses and pulse intervals for more accurate optimization of conditions. BTX developed a system that provides the versatility a researcher needs to transfect single samples in cuvettes or scale up to 96 wells quickly and simply with the addition of a High Throughput plate handler for 96 and 25 well electroporation. Other transfection applications include in vivo, in utero, ex vivo tissues and in ovo transfections using our array of specialty electrodes from BTX.

Wide Voltage and Pulse Length Range

With the ability to achieve a wide range of field strengths with voltage settings up to 3000 V and pulse lengths as low as 10 µs, the researcher can set parameters to allow for molecules of various sizes to be delivered into the cells efficiently while maintaining high cell viability.

Multiple Pulsing

Many cell types can be difficult to transfect due to the delicate nature of the cell line. Multiple pulsing and the ability to set intervals between pulses allow cells the opportunity to recover between pulses resulting in higher cell viability and efficient transfections.

High Throughput (HT)

The ECM 830 can be coupled with our specially designed HT plate handler, which can transfect up to 96 or 25 well samples quickly and efficiently. This greatly reduces the time to optimize experiments and process large number of samples.

Gene Silencing

The use of siRNA to analyze gene function is fundamental for research. The ECM 830 has been used successfully for this application with inhibition and cell viabilities of up to 90%. It has been reported recently that single cell expression of miRNA in a mouse brain was successfully achieved with the ECM 830.
ECM® 830
Square Wave Electroporation System
See page 22 for details.

The ECM 830 is a highly flexible square wave electroporation generator that may be used for in vitro and in vivo transfections.

NEW! BTXpress™
High Performance Electroporation Solution
See page 30-31 for details.

PC12 cells were transfected with hGFP using the ECM 830 system. GFP expression was observed 48hrs. post transfection.

Anne Chiaramello, Ph.D Associate Professor, George Washington University Medical Center
In Vivo, In Utero & Applications

The delivery of genes and drugs directly into living tissues has significant implications in gene therapy applications, cancer treatments, vaccine development and transgenic animal production. Tissues and whole embryos can be transfected with the use of specialty electrodes for the following methods; in vivo, in ovo, in utero and ex vivo tissues. Electroporation mediated gene and drug delivery has been shown to substantially increase intracellular uptake and expression of DNA, siRNA and miRNA in a variety of tissue such as muscle, skin, liver, retina, testis and kidney.

The use of our square wave technology provides the gentle power needed to efficiently deliver the genes and molecules to the various tissues while still maintaining the viability critical for the survival of tissue. Other more delicate in vivo tissues that are successfully electroporated include in utero embryos, brain tissue in both embryo and adult animal and marine species such as zebra fish.

In Vivo

BTX offers researchers a wide selection of specialty electrodes to deliver molecules such as DNA, siRNA, miRNA and various drugs into tissues of living animals. This technique is a valuable tool which assists in the evaluation of a gene function and cell development. Depending on the research application, BTX offers both invasive and non-invasive electrodes. BTX provides the tools for efficient, easy and reproducible transfections into specific tissues, embryos and ex vivo samples.

In Utero

Tweezertrodes™ and Genepaddles™ are ideally shaped to electroporate into rat or mouse embryos allowing the user to study the postulated roles that genes play during embryonic development.

In Ovo

The use of electrodes such as the L-shaped Genetrodes™ have been established as an effective method for introducing molecules such as DNA, siRNA and miRNA into embryos for the study of development, gene function and protein expression.

Oocytes

Studies of gene function through gene silencing is a powerful technique that is not limited to cultured cells. BTX has an entire line of electrodes that make siRNA delivery possible into intact blastocysts. Soares et al. 2005 used BTX ECM 2001 generator and flat electrodes to introduce RNA to study the signaling pathways in the developing mouse embryo.

Zebra Fish

Zebrafish have shown to be a very useful model for studying vertebrate development given the transparency of the fingerlings during early stages of development. Rambabu et al. 2005 used a BTX ECM 830 and Tweezertrodes™ in conjunction with microinjection of naked DNA to study the effect of electroporation as a method for gene delivery into adult zebrafish.

Mouse Embryonic Brain

With the help of BTX electroporation generators Tonelli et al. 2007 were able to transfect a dual-fluorescence reporter/sensor plasmid into the mouse embryonic brain. They developed a technique to detect expression at the single cell level making it possible to monitor miRNA appearance and disappearance in defined cell lineages during vertebrate development.

Transgenic Animal Development

Development of transgenic animals using standard methods is highly time consuming and is costly. With the help of BTX square wave electroporation Majumdar et al. 2008 was able to in vivo transfection to deliver genes directly into undifferentiated germ cells in mouse testis to establish a stably transfected spermatogonial cells. These mice were then mated to wild type females and sired transgenic offspring for up to a year following transfection.

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**ECM® 830**
Square Wave Electroporation System
See page 22 for details.

The ECM 830 is a highly flexible square wave electroporation generator that may be used for in vitro and in vivo transfections.

**ECM® 2001**
Square Wave Electrofusion Electroporation System
See page 23 for details.

**Platinum Tweezertoques™**
See page 34 for details.

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**Figure 1:**
Provided by Carmen Bertoni Ph.D, Department of Neurobiology UCLA. Bioluminescence Imaging of Tibialis anterior muscles injected with a luciferase plasmid and electroporated compared to injection alone.

**Figure 2:**
Provided by Carmen Bertoni Ph.D Dept. of Neurobiology UCLA. Stable long term expression obtained after intramuscular injection of a PhiC31 plasmid encoding the green fluorescence protein (GFP) under the control of a muscle specific promoter followed by electroporation.

**Figure 3:**
A. Sagital views of a P15 mouse 2 weeks post electroporation; 60 µm sections. In addition to the RMS, GFP-positive cells can be found throughout the olfactory bulb. B/C. Enlarged views of the boxed regions in (a) showing olfactory bulb (b), and the RMS (c). Inset in B highlights a periglomerular cell.
Electrofusion, Mam Oocyte & Plant

Electrofusion is a highly efficient, reproducible and non-toxic technique used in a wide variety of applications. The number of applications requiring the use of electrofusion has greatly increased in the past decade and include: hybridoma productions for antibody expression, stem cell development, genetically modified plant protoplast, tetraploid fusion and nuclear transfer for transgenic development. Many applications have clinical significance in diagnostic testing, therapeutics and vaccine development.

The ECM® 2001 is a versatile system for both Electrofusion and Electroporation. It incorporates both AC and DC square wave pulsing capabilities to allow for plant protoplast fusion, embryo manipulation and mammalian cell transfections. Cells are easily manipulated under the microscope using specially designed BTX microslide fusion chambers. These chambers help to deliver a gentle, low intensity, high frequency AC pulse to align the cells while the DC square wave pulsing capabilities to allow for plant protoplast fusion, embryo manipulation and mammalian cell transfections.

Applications

- Hybridoma Production
- Nuclear Transfer
- Stem Cell Production
- Mammalian Cell Fusion
- Oocyte Transfection
- Mammalian Cell Transfection
- In Vivo Applications
- AC/DC

The 1 MHz AC frequency feature of the ECM 2001 results in quick and simple alignment of cells. The post fusion AC pulse option maintains alignment during cell recovery resulting in a higher number of fusion couples. Voltage settings of 10V up to 3000V pulse lengths of 0.01 - 0.99 msec and multiple pulsing upto 9 pulses can be selected in the DC mode for unmatched fusion capabilities.

Dual System

The ECM 2001 is not only an efficient stand alone electrofusion system capable of a broad variety of fusion applications, this system is equally as powerful as an electroporator. The wide range of user controlled parameters includes voltage, pulse lengths and multiple pulsing capabilities making this system an effective tool for efficient mammalian cell transfections.

Plant Fusion

Electrofusion can be used to fuse plant protoplasts to generate hybrids and create crops with desirable traits. Fusion of the plant protoplast is easily carried out by using the AC feature of the ECM 2001 to align the protoplast while the gentle square wave DC pulse is applied with moments of the alignment resulting in successful fusion. This method is performed with no cyto-toxic effects common with comparable chemical methods.

Hybridoma and Cell Fusion

Electrofusion using the ECM 2001 is an extremely efficient, highly reproducible and non-toxic method for the fusion of mammalian cells. Hybridoma development for monoclonal antibody production and cell fusion for cancer vaccine development are some of the most common applications for electrofusion. It has been reported that significantly higher rates of genuine dendritic and tumor cell hybrids were produced. These hybridomas are multinuclear and dually fluorescent for individual cell-specific markers and shown to be therapeutic in murine tumor models compared to PEG (Parkhurst et al. 2003).

Other electrofusion applications include two cell embryo hybrids for tetraploid productions, nuclear transfer for transgenic animal and stem cells development. Increased cell fusion rates of 90% were reported, as well as post fusion viability when compared to chemical fusions (Orentas et. al. 2001).

Nuclear Transfer Electroporation

Nuclear Transfer Electrofusion is a method utilized for introducing a nucleus from a donor cell (fetal cell or adult cells) into an un-fertilized recipient oocyte via the use of AC/DC electrical pulses to fuse the cell membranes. This technique is often used to generate transgenic animals producing therapeutic proteins which can be expressed in various species including Bovine, Caprine, Porcine and Ovine. Transgenic development is also widely used to study gene function and to develop stem cells for therapeutic research.

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Zhe Yul, Qingyu Fan, Zirbao Hao and Hua Long; Specific Antitumor Effects for Tumor Vaccine Produced by Electrofusion between Osteosarcoma Cell and Dendritic Cell in Rats. Cellular & Molecular Immunology, Vol 1, No. 8, 2004
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The ECM 2001 is a multifunctional square wave electro cell fusion and electroporation generator capable of AC and DC square wave pulses. The CE/ETL marked ECM 2001 is used for a variety of applications from embryo manipulation to hybridoma production to plant tissue transformation.

*ECM® 2001*

*Square Wave Electrofusion Electroporation System*

See page 23 for details.

**Microslides**

See page 39 for details.
Microinjection is a well-established technique used routinely for injection of animal cells, tissues and embryos to insert genetic material such as DNA, RNA, proteins and macromolecules directly into animal cells or embryos a cell cytoplasm or nucleus. Genetic material is inserted via a needle varying in size from 0.5μM to 20μM in diameter. The needle penetrates the cell membrane and/or the nuclear envelope. The process is performed, observed and controlled by using a micromanipulator specialized microscope setup. This technique is widely used by researchers for genetic engineering of cells by modifying, silencing or creating knockouts to study gene targeting and function. Microinjection and electroporation can be combined for the transfection of mammalian cells and tissues for gene therapy applications. This highly effective method is routinely used to insert genes into early stage pronuclear embryos for transgenic development applications for therapeutics. Microinjection is routinely used for nuclear transfer applications, cell biology and viral studies.

Pressure Control
- Fill/Clear/Hold

The MicroJect 1000 is a versatile injection system, providing the consistency and reliability to deliver precise volumes ranging from femtoliter to microliters through a stable compressed gas pressure mechanism for a set duration of time. The MicroJect 1000 Max provides key pressure features designed to maximize the researchers injection potential with two negative and three positive pneumatic features. The negative pressure or vacuum functions provides convenient filling functions, holding and clearing function critical for efficient microinjection applications.

- Fill: This feature reduces waste of valuable injection material using the negative pressure feature to conveniently fill the microinjection needles from the tip.
- Hold: The negative pressure and vacuum functions provides the means to immobilize and manipulate a cell or oocytes using a micropipette.
- Clear: The high pressure pulse feature allows quick clearing of the pipette to remove potential clogs when working with smaller diameter pipette sizes for small volumes.

Balance Pressure

It is all about the balance of pressure with our Microject 1000 system. The unique “Balance” feature provides a secondary balance pressure to maintain positive pressure on the injection pipette, this prevents sample dilution by capillary action and reduces clogging of the injection needle.

MicroJect 1000 Max System

See page 27 for details.
BTX generally recommends a square waveform for mammalian cell work, and an exponential decay waveform for bacteria and yeast applications. However, there are some exceptions, and crossover in the use of our electroporation generators. We highly recommend that you contact BTX regarding your application prior to purchasing a generator system to ensure that you are getting the best possible system for your needs.

For BTX Technical Support go to www.btxonline.com or call 800-272-2775 within the U.S.

ECM® 2001
This square wave pulse electroporator and electrofusion generator is primarily used for cell fusion work and mammalian cell transfection. It can also be used for transforming bacteria, but with lower efficiencies than with an exponential decay waveform, see page 23.

ECM® 830
This square wave unit is engineered mainly for mammalian cell transfection. The 830 is also capable of performing certain cell fusion applications which will require the use of a manual cell alignment method. The basic transformation of bacteria to generate plasmids can be accomplished with 830 but with lower efficiencies compared to our exponential decay wave system (830/107-108 pfu/ug. vs. 630/108-1010 pfu/ug), see page 22.

ECM® 630
This exponential decay wave pulse generator is primarily used for bacteria and yeast transformation applications. The exponential decay wave system is used for efficient transfection of mammalian cells but much lower cell viabilities compared to square wave pulse system, with the exception of mouse embryonic stem cells. Excellent transfection is achieved with the ECM 630, see page 21.

ECM® 399
This exponential decay wave generator is our most economical unit for a lab doing mainly gram (-) bacteria and yeast applications. This unit is not recommended for mammalian transfection, see page 20.
Transfection of delicate brain tissue and tissues with unique morphologies are more easily transfected with our new tissue slice chamber, L-shaped platinum needles or other BTX electrodes.

The numerous electrodes offered by BTX can be used for multiple tissues type depending on the specific application the researcher is trying to perform. To the left are some of the most common recommendations. For more assistance please contact BTX technical support.

The Genetrodes are available in 3 different sizes and the New L-Shaped Needle electrodes provides a finer diameter needle in various length tips to best suit the dimensions of your target tissue.

The electrodes can vary for plant applications depending on the target tissue.

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Electroporation Definitions Guide

AC
Abbreviation for “alternating current” which is an oscillating dielectrophoretic current in which an electrical current rises to a maximum point in one direction and falls to zero and then rises in the opposite direction and then repeats.

AC Alignment
Refers to the use of AC current to align cells prior to electofusion.

Anode
Positive electrode or terminal of a device from which electrons flow outwards.

Arc
Discharge of electrical current in a sample in which the conductivity is too great.

Capacitor
A device capable of holding an electrostatic charge between two conducting surfaces.

Capacitance
The quantity of electric charge (usually measured in Farads) which a capacitor is capable of receiving with an applied voltage.

Cathode
Negative electrode or terminal of a device to which electrons flow towards.

DC
Abbreviation for “direct current”, which is defined by the constant flow of electrons in a single direction from low to high potential.

DC Pulsing
The application of a DC pulse that is used in electroporation and the fusion step in electrofusion.

Electroporation
Applying an electrical pulse inducing a transmembrane potential which causes a reversible breakdown of the cellular membrane. This results in the formation of pores in the membrane of cells and tissues allowing exogenous molecules such as DNA, siRNA, proteins, or antibodies to enter the cell.

Electrofusion
Using electrical pulses to destabilize cell membranes to create pores and fuse cell membranes together to create a hybrid cell.

Exponential Decay
A wave in which the decay is 1/3 of the maximum peak amplitude of the pulse.

Field Strength
The voltage delivered across the electrode gap. It is expressed as kV/cm. Field strength relates to the potential difference experienced by the cell membrane in the electric field.

Pulse Length
The length of time the cell is exposed to the electrical field. Pulse length is generally believed to be related to the length of time during which the electroporation membrane pores remain open.

RC Time Constant
Product of resistance and capacitance in seconds.

Resistance
Opposition to current flow and dissipation of energy in the form of heat, typically measured in Ohms.

Stable Transfection
Integration of nucleic acids into the host chromosomes and the inheritance of associated traits in progeny cells.

Square Wave
A wave form that alternates between two fixed values for an equal amount of time.

Transfection
The introduction of nucleic acids into animal cells either as a stable or transient transfection.

Transformation
The introduction of nucleic acids into bacteria, yeast and plants.

Transient Transfections
Temporary expression of exogenous nucleic acids.
Electroporation is the application of controlled direct current (DC) electrical pulses which are applied to living cells and tissues for a short duration of time. The pulse induces a transmembrane potential which causes the reversible breakdown of the cellular membrane. This action results in the permeation or “pore formation” of the cell membrane which allows small molecules (such as dye, oligonucleotides or peptides) and large molecules (such as proteins, DNA and RNA) to be introduced into the cell. During this process the cellular uptake of the molecules continues until the pores close which can take milliseconds to minutes.

Electrofusion is an expansion of electroporation using different buffers and one or more proprietary alternating current (AC) pulse(s). Cells are brought together or “aligned” by the use of an AC pulse which causes charges to form on the cellular membrane (dielectrophoresis) resulting in alignment of cells or pearl-chain (dimer) formation. Following the AC cellular alignment the DC pulse is applied to induce permeation of the cell membrane. When cells are brought into contact during electroporation, these cells are induced to fuse. Following this DC pulse the AC pulse is maintained to allow complete cell membrane fusion during the recovery period.

Optimization of the electroporation process involves several factors. Choosing the wave form, determining field strength and adjusting pulse length are just a few critical variables. Other parameters which play a crucial role in optimization include cell diameter, DNA concentrations, temperature and electroporation buffer.

Wave Forms
Pulse shape generally falls into two categories, square wave or exponential decay wave:

**Square wave pulse**: Square wave pulses rise quickly to a set voltage level, maintains this level during the duration of the set pulse length and quickly turns off. This square wave system yields higher efficiencies and viabilities in mammalian cells. Square wave EP in vivo and ex vivo tissues, embryo’s, cell fusions and plant protoplast applications yield better results in comparison to an exponential decay wave system.

**Exponential decay wave pulse**: Exponential decay waves generate an electrical pulse by allowing a capacitor to completely discharge. A pulse is discharged into a sample the voltage rises rapidly to the peak voltage set then declines over time. The powerful exponential decay wave pulse is routinely used for transformation of gram-negative and gram-positive, bacterial, yeast, plant tissues, insect cells and some mammalian cells.

Field Strength
The field strength is measured as the voltage delivered across an electrode gap and is expressed as kV/cm. Field strength is critical to surpassing the electrical potential of the cell membrane to allow the temporary reversible permeation or “pore formation” to occur in the cell membrane. Three factors should be considered for optimizing field strength:

1. Cuvette Gap Size
2. Cell Diameter
3. Temperature

<table>
<thead>
<tr>
<th>Cell Types</th>
<th>Field Strength Ranges</th>
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<tbody>
<tr>
<td>Bacteria/Yeast</td>
<td>3-24 kV/cm</td>
</tr>
<tr>
<td>Mammalian</td>
<td>0.25-3 kV/cm</td>
</tr>
<tr>
<td>Plant</td>
<td>3-12 kV/cm</td>
</tr>
</tbody>
</table>

1. **Cuvette Gap Size**

The distance between electrodes, or “gap size” is important when optimizing your electroporation experiment. Field strength is calculated using voltage divided by gap size. For example, using a 4mm gap cuvette with 500V would provide a field strength of 1.25kV/cm. If instead of a 4mm gap cuvette, a 2mm gap cuvette was used, the voltage would have to be reduced by half or 250V in order to maintain the same field strength of 1.25kV/cm. It is possible to derive the voltage needed to accomplish electroporation if the desired field strength and gap size are known. The calculation for this is Field strength (kV) multiplied by gap size (cm) equals voltage. For example, if a user was certain that a 1.25 kV/cm field strength was required in a 1mm gap cuvette the calculation would be: 1.25kV x 0.1cm = 0.125kV or 125volts.

Example: A field strength of 1.25 kV/cm
- 4mm gap cuvette = 500 volts
- 2mm gap cuvette = 250 volts
- 1mm gap cuvette = 125 volts

2. **Cell Diameter**

Generally, smaller cell sizes require higher voltages while larger cell diameters require lower voltages for successful cell membrane permeation.

<table>
<thead>
<tr>
<th>Cell Diameter</th>
<th>Cuvette 4mm Room Temp. (Volt)</th>
<th>Cuvette 4mm 4°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>500 Volts</td>
<td>1000 V</td>
</tr>
<tr>
<td>15</td>
<td>350 Volts</td>
<td>700 V</td>
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<tr>
<td>20</td>
<td>250 Volts</td>
<td>500 V</td>
</tr>
<tr>
<td>30</td>
<td>180 Volts</td>
<td>360 V</td>
</tr>
<tr>
<td>40</td>
<td>130 Volts</td>
<td>250 V</td>
</tr>
<tr>
<td>50</td>
<td>100 Volts</td>
<td>200 V</td>
</tr>
</tbody>
</table>
3. Temperature

The temperature at which cells are maintained during electroporation effects the efficiency of the electroporation for several reasons. For a majority of mammalian cell lines are effectively electroporated at room temperature. Samples which are pulsed at high voltage or exposed to multiple pulses and long pulse durations can cause the sample to heat up. These conditions cause increased cell death and lowers the transfection efficiency. Maintaining the sample at lower temperatures can diminish the heating effects on cell viability and efficiency. Since electroporation causes the transient formation of pores, keeping the cells at lower temperature following the pulse may allow the pores to remain open longer to allow more uptake of the exogenous molecule. Yet lower temperatures on other cell lines can be damaging and cause high cell mortality. This effect is specific to each cell line and should be considered during optimization studies. The standard pulse voltage used for cells at room temperature will need to be approximately doubled for electroporation at 4°C in order to effectively permeate the cell membrane.

Pulse Length

The pulse length is the duration of time the sample is exposed to the pulse. This is measured as time in micro to milliseconds ranges. Adjusting this parameter is dependent on the pulse generator in use square wave or exponential decay wave. The pulse length in a square wave system can be inputted directly. The pulse length in an exponential decay wave system is called the “time constant” which is characterized by the rate at which the pulse energy (e) or voltage is decayed to 1/3 the original set voltage. This time constant is modified by adjusting the resistance and capacitance (RC) values in an exponential decay. Time constant calculation T=RC, where T is time and R is resistance and C is capacitance.

The pulse length works indirectly with the field strength to increase pore formation and therefore the uptake of target molecules. Generally, during optimization of parameters an increase in voltage should be followed by an incremental decrease in pulse length. Decreasing the voltage, the reverse is true. Pulse length is a key variable that works hand in hand with other parameters to maximize the results for a given cell type.

Number of Pulses

Electroporation is typically carried out as a single pulse for most cell types. However, other cell lines may require multiple pulses to achieve maximum transfection efficiencies. Usually lower voltages are used when applying multiple pulses in order to gradually permeate the cell membranes. This allows the transfer of molecules while avoiding damage to delicate or whole tissue samples. This method of multiple pulsing is critical for maximum gene delivery without causing tissue damage to in vivo, in utero and ex-plant tissue environments. The use of multiple pulsing will require the optimization of key electrical parameters including voltage and pulse length. Typically, for in vivo applications the use of lower voltages between 10-100 volts with pulse lengths ranging 30-50ms can provide efficient transfection. The optimal voltage, pulse length and number of pulses will vary depending on the cell type and molecule (DNA or RNA) transfected.

Electroporation Buffer

The buffers used for electroporation can vary depending on the cell type. Many applications use highly conductive buffers such as PBS (Phosphate Buffered Saline <30 ohms) and HBSS (Hepes Buffer <30 ohms) or standard culture media which may contain serum. Other recommended buffers are hypotonic buffers in which cells absorb water shortly before pulse. This swelling of the cells results in lowering the optimal permeation voltage while ensuring the membrane is more easily permeable for many cells but can be damaging to others. Prokaryotic cells such as bacteria require the use of high resistance buffers (>3000 ohms) for this reason proper preparation and washing of the cells is essential to remove excess salt ions to reduce the chance of arcing. Ionic strength of an electroporation buffer has a direct affect on the resistance of the sample which in turn will affect the pulse length or time constant of the pulse. The volume of liquid in a cuvette has significant effect on sample resistance for ionic solutions, the resistance of the sample is inversely proportional to the volume of solution and pH. As the volumes are increased resistance decreases which increases the chance of arcing, while lowering the volume will increase the resistance and decrease the arc potential.

BTX now offers BTXpress™ High Performance Electroporation Solution, a low conductance buffer that achieves higher transfection efficiencies with minimal cell toxicity. The BTXpress buffer is a single buffer developed to facilitate high efficiency gene delivery into mammalian cells.

DNA/RNA Concentrations

Electroporation is typically thought of as a nucleic acid (DNA, mRNA, siRNA and miRNA) transfer method into prokaryotic and eukaryotic cells. Electroporation is not limited to just nucleic acid delivery, it can introduce proteins, antibodies, small molecules and fluorescent dyes. The standard range of DNA used for transfections is 5-20µg/ml for most cell types; however in some instances increasing the DNA concentration as high as 50µg/ml improves transfection efficiency without changing other parameters. Determining the optimal DNA concentration through a DNA titration can be beneficial. The size of a molecule will have an effect on the electrical parameters used to transfect the cell. Smaller molecules (siRNA or miRNA) may need higher voltage with microsecond pulse lengths and larger molecules (DNA) may need lower voltages with longer pulse lengths. Buffers such as EDTA or Tris can drastically reduce the transfection efficiency. Therefore, we recommend resuspending DNA in distilled water. Finally, electroporating ligation mixtures into E.coli can cause arcing and reduced transformations. Diluting the ligation mixture a minimum of 1:5 with dH2O, dialysis, or ethanol precipitation can significantly improve transformation efficiencies and reduce the potential for arcing.
Applications

The ECM 399 is an exponential decay wave electroporation system specifically designed to deliver the field strengths and pulse lengths required for the simple transformation of bacteria and yeast cells. In low voltage mode the ECM 399 has a limited capability for transfecting some mammalian cell lines. The ECM® 399 is ideal for basic transformation in research and academic environments. It is easy to operate, cost effective, compact in size and portable.

Combination System

BTX provides a combination system which has the power of both its exponential decay and square wave technologies for labs involved in multiple applications. These labs need the versatility of the BTX systems to range from prokaryotes to eukaryotes with the ability to transfect delicate in vivo tissues efficiently. This combo system includes the power of the ECM 399 exponential decay wave generator to provide the highest transformation efficiencies of basic bacteria and yeast strains. This package option also includes the gentle strength and versatility of the ECM 830 Square Wave System to provide high transfection efficiencies with equally high cell viabilities in mammalian cells and in vivo tissues. BTX offers the ECM 399/ECM 830 Combo System complete with a PEP and a safety stand for cuvettes. These systems can be used together or separate as independent systems for operation in different labs with no extra components needed.

Specifications

- **Operational Status**: Internal self test upon start-up
- **Interface**: Digital User Interface
- **Charge Time**: 5 sec maximum
- **Voltage Range**:
  - **LV Mode**: 2 – 500 V HV Mode/ 2 V resolution
  - **HV Mode**: 10 – 2,500 V HV Mode/10 V resolution
- **Capacitance**:
  - **LV Mode**: 1,050 µF Fixed
  - **HV Mode**: 36 µF Fixed
- **Resistance**:
  - **LV Mode**: 150 ohm Fixed
  - **HV Mode**: 150 ohm Fixed

Item # | Description
--- | ---
45-0000 | Electroporation System includes ECM 399 Generator, PEP, Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each) and Cuvette Rack 660
45-0050 | ECM 399 Generator Only
45-0060 | Combination package includes ECM 830 Generator, ECM 399 Generator, Safety Stand, PEP, 30 Cuvettes, (10 each: 1mm, 2mm and 4mm) and Cuvette Rack

To order these products, please contact BTX at **800-272-2775** (US) or **508-893-8999** (outside the US) or **techsupport.btx@harvardapparatus.com** or visit **www.btxonline.com** to get complete list of distributors in your area.
ECM® 630
Exponential Decay Wave Electroporation System

Applications
• Transformation of Bacteria and Yeast
• Transfection of Mammalian Cells
• Transformation of Plant Tissue and Plant Protoplast
• High Throughput 96 & 25 Well Electroporation

The ECM 630 is an exponential decay wave electroporation generator providing a broad range of voltage and time constant for full flexibility in varying applications. The ability to select the resistance and capacitance values and adjust the range of voltages is the key to achieving the optimal time constants and field strengths needed for efficient transformation of prokaryotes and eukaryote transfection. This system is an outstanding value for researchers working with bacteria, yeast, stem cell transfection, plant transformation and insect transfection. Flexibility is important to a researcher, so BTX has designed a plug and play system for our ECM 630 system to transition between standard cuvettes and to a 96 well electroporation plate using our High Throughput plate handler.

96-Multi-Well Electroporation
Transition from standard cuvette work using the safety stand to multi-well electroporation is quick and simple with the addition of the High Throughput (HT) plate handler and plates. The HT plate handler accommodates either 96 & 25 well electroporation plates and it operates with an existing ECM 630 generator or is offered as an ECM 630 HT System for easy scale up. The HT System offers the researcher the advantage of multi-well technology. High Throughput electroporation permits for large numbers of samples to be quickly processed or easy optimization of electroporation conditions for the highest possible efficiencies.

Monitoring Option
The ENHANCER 3000 allows the researcher to monitor and track key electrical parameters used in electroporation applications. The electrical pulse data is captured as both a graphic display of the wave form and electrical output values following each experiment. This data can be stored on a memory stick or downloaded to a computer easily by using the USB port for potential analysis, documentation and validation purposes.

Combination System
This combo system includes the power and flexibility of the ECM 630 Exponential Decay Wave Generator to provide the highest transformation efficiencies for a wide range of bacteria and yeast strains. This combo also contains the gentle strength and versatility of the ECM 830 Square Wave System to provide high transfection efficiencies with equally high cell viabilities in mammalian cells and in vivo tissues. BTX offers the ECM 630/ECM 830 Combo System complete with two safety stands and sample cuvettes. These systems may be used together or separate as independent systems for operation in different labs with no extra components needed.

Specifications

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<td>Arc Control</td>
<td>Arc Quenching™</td>
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<td>Voltage Range</td>
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<td></td>
<td>50 – 2500 V HV Mode/ 5 V resolution</td>
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<td>25 µF, 50 µF HV Mode</td>
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Item # Description

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<td>45-0422</td>
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<td>45-0412</td>
<td>Includes ECM 630 Generator, 6 x 25-Well Plates (2 mm), Plate Seals, and HT-100 Plate Handler</td>
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<td>45-0061</td>
<td>Combination package includes ECM 830 Generator, ECM 630 Generator, 2 x Safety Stands, 30 Cuvettes (10 each: 1mm, 2mm and 4mm) and Cuvette Rack</td>
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<td>45-0071</td>
<td>ENHANCER 3000 Probe, ENHANCER Interface Box, Oscilloscope, Communications Module, ECM 630 Generator, Safety Stand, 30 Cuvettes (10 each 1 mm, 2 mm and 4 mm) and Cables</td>
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</table>

Visit the BTX website for hundreds of protocols and publications
www.btxonline.com
ECM® 830
Square Wave Electroporation System

Applications
• Transfection of Mammalian Cells
• In Vitro, In Vivo, Ex Vivo & In Ovo Tissue Transfection
• Nuclear Transfer
• Plant Protoplast Transfection
• High Throughput 96 and 25 well Electroporation

The ECM 830 is a square wave pulse generator designed for In Vitro and In Vivo electroporation applications. BTX square wave technology provides the advantage of efficient cell transfer and high cell viability for numerous applications. The versatility of the ECM 830 applications for gene, drug and protein delivery includes; mammalian cells, in vivo and ex-vivo tissues, zebra fish tissue and embryos, nuclear transfer, embryo manipulation, plant protoplast and basic bacteria and yeast transformations. The ECM 830 possesses key features including a wide range of voltages from 5 to 3000 volts, fine voltage discrimination, pulse durations from 10µsec to 10sec, user control of pulse intervals, Arc Quenching™, digital display of output of voltage and pulse length for precise optimization of experiments. It is a true laboratory work-horse with a 2-year warranty. The ECM 830 can be used in combination with a wide array of BTX specialty electrodes and accessories to enhance your molecular and drug delivery for In Vivo and Ex Vivo experiments. Flexibility is important to a researcher, so BTX has designed a plug and play system for our ECM 830 system to transition between standard plates and sample cuvettes. These systems may be used together or separate as independent systems for operation in different labs with no extra components needed.

96-Well Electroporation
The High Throughput (HT) 96 & 25 well systems offer the researcher the advantage of multi-well technology. This permits a large number of samples to be quickly processed for routine applications or easy optimization of electrical and biological conditions. Simply replacing the conditions needed to obtain the best possible efficiencies using the BTX ECM 830 pulse generator and HT plate handler.

Monitoring Option
The ENHANCER 3000 allows the researcher to monitor and track key electrical parameters used in electroporation applications. The electrical pulse data is captured as both a graphic display of the wave form and electrical output values following each experiment. This data can be stored on a memory stick or downloaded to a computer easily using the USB port for potential analysis, documentation and validation purposes.

Combination System Options
This combo system includes the power and flexibility of the ECM 630 exponential decay wave generator to provide the highest transformation efficiencies for a wide range of bacteria and yeast strains. The gentle strength and versatility of the ECM 830 square wave system provides high transfection efficiencies with equally high cell viabilities in mammalian cells and in vivo tissues. BTX offers the ECM 630/ECM 830 combo system complete with two safety stands and sample cuvettes. These systems may be used together or separate as independent systems for operation in different labs with no extra components needed.

Specifications

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<tr>
<th>Operational Status</th>
<th>Internal self test upon start-up</th>
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<tr>
<td>Input</td>
<td>110 V/220 V Universal</td>
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<tr>
<td>Charge Time</td>
<td>5 sec maximum (without delay)</td>
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<td>Pulse Length Range</td>
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<tr>
<td></td>
<td>1 msec – 999 msec LV Mode/ 1 msec resolution</td>
</tr>
<tr>
<td></td>
<td>1 sec – 10 sec LV Mode/ 0.1 sec resolution</td>
</tr>
<tr>
<td></td>
<td>10 µs – 600 µs HV Mode/ 1 µs resolution</td>
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<tr>
<td>Voltage Range</td>
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<td>Programmability</td>
<td>Storage for 3 protocol setups (V,t,n,interval)</td>
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<td>Arc Control</td>
<td>Arc Quenching™</td>
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<td>500 A limit at 100 µs</td>
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<tr>
<td>Remote Operation</td>
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Please contact BTX Technical Services at 1-800-272-2775 or techsupport.btx@harvardapparatus.com for assistance.

Item # | Description
--- | ---
45-0002 | ECM 830 Electroporation System includes, ECM 830 Generator, 630B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each) and Cuvette Rack 660
45-0052 | ECM 830 Generator Only
45-0421 | HT 96/200 includes ECM 830 Generator, 2 x 96-Well Plates (4 mm), Plate Seals and HT-200 Plate Handler
45-0411 | HT 25/200 includes ECM 830 Generator, 6 x 25-Well Plates (4 mm), Plate Seals and HT-200 Plate Handler
45-0061 | ECM 830 / ECM 630 Combination Package includes ECM 830 Generator, ECM 630 Generator, 2 x Safety Stands, Sample Package of Cuvettes and Cuvette Rack
45-0060 | ECM 830 / ECM 399 Combination Package includes ECM 830 Generator, ECM 399 Generator, Safety Stand, PEP, Sample Package of Cuvettes and Cuvette Rack
45-0072 | ECM 830 / ENHANCER 3000 System: ENHANCER 3000 Probe, ENHANCER Interface Box, Oscilloscope, Communications Module, ECM 830 Generator, Safety Stand, 30 Cuvettes (10 each 1 mm, 2 mm and 4 mm) and Cables
ECM® 2001
Electro Cell Fusion & Electroporation System

Applications
• Cell Fusion
• Nuclear Transfer
• Embryo Manipulation
• Hybridoma Production
• Mammalian Cell Transfection
• Plant Protoplast Fusion
• Stem Cell Production

The ECM 2001 is a multipurpose pulse generator. This system offers AC/DC pulsing and a variety of pulse lengths with multiple pulsing features. This generator has the capability of performing electrofusion as well as electroporation.

Fusion
Electrofusion is carried out by applying both AC and DC waves. Fusion is achieved by the generation of a proprietary AC wave form for benign dielectrophoretic alignment of cells. Microsecond switchover time from AC to DC creates efficient fusion results. After fusion, the AC pulse reaplication maintains compression of the cells following the DC pulse for the rounding off process, resulting in a higher number of hybrids. The 1 MHz AC pulse aligns cells together in “real time”, saving time (seconds vs. hours) in comparison to PEG methods. Blastomeres and Oocytes can also be aligned to the correct position for better fusion accuracy during nuclear transfer and embryo manipulation.

Electroporation
The ECM 2001 can function as a powerful stand alone electroporation system for efficient cell transfection or for in vivo tissue transfection applications. Using the ECM 2001 for standard mammalian cell transfections the AC feature is turned off and the DC mode can now be set as a square wave electroporation device. The range of voltages and pulse lengths that can be set coupled with the ability to carry out up to 9 pulses per experiment make this an all around flexible system for any lab.

Monitoring Option
The ENHANCER 3000 allows the researcher to monitor and track key electrical parameters used in electroporation and electrofusion applications. The electrical pulse data is captured as both a graphic display of the way form and electrical output values following each experiment. This data can be stored on a memory stick or downloaded to a computer easily by using the USB port for potential analysis, documentation and validation purposes.

Specifications
AC Parameters (Alignment)
Proprietary nonsinusoidal wave shape
- Frequency: 1 MHz
- Voltage: 0 – 75 V RMS (zero to peak)
- Duration: 0 – 99 sec
- Post fusion AC: 1/10 of pre fusion amplitude
- Post fusion ramp: 1 – 9 sec
- Pause between AC/DC: 50 µsec

DC Pulse Parameters (Fusion) (Electroporation)
High Voltage Mode
- Voltage: 10 – 3000 V
- Pulse Length: 1 – 99 µsec/ 1 µsec resolution

Low Voltage Mode:
- Voltage: 10 – 500 V
- Pulse Length: 1 – 9 pulses
- Number of Pulses: 0.01 – 0.99 msec/ 0.01 msec res

Item # Description
45-0011 Electroporation System includes ECM 2001 Generator, Safety Stand 630B, Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each), Cuvette Rack 660
45-0012 Embryo Manipulation System includes ECM 2001 Generator Micro-Slides 450, 450-1, 453 and Connection Cable
45-0010 Electro Cell Fusion System includes ECM 2001 Generator, Micro-Slides 450, 453, Meander Fusion Chamber 454, Flat Electrode/Divergent Field 484, Electrode Adapter, Connection Cable, Safety Stand 630B Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each), Cuvette Rack 660
45-0080 ECM 2001 Generator Only
45-0013 ENHANCER 3000 Probe, ENHANCER Interface Box, Oscilloscope with USB communications, ECM 2001 Generator, Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each) and Cables

Cables*
Item # Description
45-0216 Micrograbber Cables
45-0217 Banana to Banana Plug, 10 ft.
45-0089 Adapter Set Banana to Square Post
45-0088 Adapter Set F/F Banana to Square Splice
45-0087 Adapter Micrograbber

* For full selection of cables see page 43.
ECM® 830 High Throughput
HT Multi-Well Electroporation System

Applications

• Mammalian Cells
• Primary Cells
• Stem Cells
• siRNA Libraries

The BTX High Throughput (HT) System offers multi-well electroporation technology for processing multiple samples in seconds. Using the HT Multi-Well plates instead of traditional cuvettes, the researcher can transition from a single cuvette to either a 96 well or 25 well electroporation plate by using one simple plate handler. This increases yields and the number of experiments runs in a single day. Experiments take seconds to run, allowing for quick and efficient optimization of the electrical and biological parameters. Once optimized, samples are rapidly processed increasing yields and saving valuable time and money.

The HT plate handler is compatible with the ECM 830 and some older ECM 830 generators (for more details regarding compatibility of your ECM 830 systems please contact BTX tech support).

The HT System is comprised of 3 components: The HT Multi-Well Plates, an HT Plate Handler and the BTX ECM 830 Generator.

HT Plates

Each HT Plate consists of either 96 or 25 individual wells with integrated electrodes. The 96-well plate assumes a traditional 96 well format i.e., 12 columns of 8 wells each. The 25-well format has 5 columns of 5 well each. Four different Multi-Well Plates are available: 96-well with 4mm gap, 96-well 2mm gap, 25-well 4mm gap and 25-well 2mm gap.

Rapid protocol optimization of transfection parameters can be obtained by loading a plate with unique experimental samples. Optimization of electrical parameters can be achieved by pulsing each column within the plate with variable electrical settings. The same electrical settings are applied to each well within a column.

Plate Handler

The key to the HT system is the combination of the Plate Handler and Multi-Well Plates. The Plate Handler holds the HT Multi-Well Plates; much like the safety stand holds the cuvettes. It delivers the pulse(s) to the wells using parameters set in the ECM 830 generator. Specifically, the HT 200 plate handler offers the option of the delivery of multiple pulses column by column automatically.

Generator

The final component of the HT System is a BTX ECM 830 Square Wave Electroporation Generator.

Item # Description
45-0421 Includes ECM 830 Generator, 4 mm gap, 2 x 96-Well Plates, Plate Seals and HT-200 Plate Handler
45-0411 Includes ECM 830 Generator, 4 mm gap, 6 x 25-Well Plates, Plate Seals and HT-200 Plate Handler
45-0452 96-Well Disposable Electroporation Plates, 4 mm gap, 250 µl, 1 plate
45-0450 96-Well Disposable Electroporation Plate, 2 mm gap, 125 µl, 1 plate
45-0462 25-Well Disposable Electroporation Plate, 4 mm gap, 250 µl, 1 plate
45-0466 25-Well Disposable Electroporation Plate, 2 mm gap, 125 µl, 1 plate
45-0463 25-Well Disposable Electroporation Plate, 4 mm, 250 µl, pkg. of 6 plates
45-0467 25-Well Disposable Electroporation Plates, 2 mm, 125 µl, pkg. of 6 plates
45-0401 HT-200 Plate Handler, Automatic Column Switching

To order these products, please contact BTX at 800-272-2775 (US) or 508-893-8999 (outside the US) or techsupport.btx@harvardapparatus.com or visit www.btxonline.com to get complete list of distributors in your area.
ECM® 630 High Throughput
HT Multi-Well Electroporation System

Applications

• Bacteria
• Yeast
• Insect Cells
• cDNA Libraries

The BTX High Throughput (HT) System, offers a multi-well electroporation technology for processing multiple samples in seconds. Using the HT Multi-Well plates instead of traditional cuvettes, the researcher can transition from a single cuvette to either a 96 well or 25 well electroporation by using one simple plate handler. This increases yields and the number of experiments runs in a single day. Experiments take seconds to run, allowing for quick and efficient optimization of the electrical and biological parameters. Once optimized, samples are rapidly processed increasing yields and saving valuable time and money.

The HT plate handler is compatible with the ECM 630 including older ECM 630 generators.

The HT System is comprised of 3 components: The HT Multi-Well Plates, an HT Plate Handler and the BTX ECM 630 Generator.

HT Plates

Each HT plate consists of either 96 or 25 individual wells with integrated electrodes. The 96-well plate assumes a traditional 96 well format i.e., 12 columns of 8 wells each. The 25-well format has 5 columns of 5 well each. Four different Multi-Well Plates are available: 96-well with 4mm gap, 96-well 2mm gap, 25-well 4mm gap and 25-well 2mm gap.

Rapid protocol optimization of transformation and transfection parameters can be obtained by loading a plate with unique experimental samples. Optimization of electrical parameters can be achieved by pulsing each column within the plate with variable electrical settings. The same electrical settings are applied to each well within a column.

Plate Handler

The key to the HT system is the combination of the Plate Handler and Multi-Well Plates. The Plate Handler holds the HT Multi-Well Plates; much like the safety stand holds the cuvettes. It delivers a single pulse to the wells using parameters set in the ECM 630 generator. Specifically, the HT 100 plate handler applies a single pulse to each column of a plate while switching through columns is performed manually.

Generator

The final component of the HT System is a BTX ECM 630 Exponential Decay Wave Electroporation Generator.

Visit the BTX website for hundreds of protocols and publications
www.btxonline.com
Enhancer 3000 Monitoring System

ECM / ENHANCER 3000 Monitoring Systems
These Systems pair electroporation methods with the advanced monitoring capabilities of the ENHANCER 3000 System. They allow complete documentation and storage of data for further review and analysis. This system is available separately for use with your existing electroporation equipment.

Specifications

Input Voltage

Common Mode:
- Range: ±7000 V (DC+Peak AC) or 2500 V rms at 1/100 & 1/1000

Output Voltage:
- Maximum Amplitude: ±7 V (into 50 kΩ load)
- Offset (typical): ±5 mV
- Power Requirements: 4 AA batteries and AC plug adapter
- Length of BNC Cable: 88.9 cm (35 in)
- Length of Input Leads: 30.5 cm (12 in)

ENHANCER 3000 High Voltage Interface Box Specifications

Input, Output, Probe Connections:
- Type: 4 mm Banana Jack
- Voltage: 2500 V rms, 3500 V pk CAT II
- Current: 15 A, maximum continuous
- Current (Peak): 1000 A for 100 µsec

Applications

- Optimize and Troubleshoot Electroporation Settings
- Capture and Print Results for Documentation Purposes
- Track & Download Images to Computer for Analysis

The BTX Enhancer 3000 offers a novel approach to monitoring critical parameters while performing electroporation applications. The system allows researchers to maintain efficiencies, optimize both electrical and biological parameters, view sample runs, troubleshoot possible problems and easily perform routine quality control. Communications using the USB data port permits storage and documentation of data for further analysis.

The ENHANCER 3000 Monitoring System can monitor all key electroporation parameters including:

- Wave Form
- Peak Amplitude
- Field Strength
- Pulse Lengths
- Pulse Intervals
- AC duration

The electrical pulse data is captured as both a graphic display of the waveform and electrical output values following each electroporation experiment from generators w/ external pulse capability.

The ENHANCER 3000 System is comprised of three components: a Voltage Probe, an Interface Box and a digital Oscilloscope. The Voltage Probe and Interface Box together comprise the voltage monitor, while the Oscilloscope displays waveform images from the actual electrical pulse. This system offers a solution for evaluating critical electroporation settings and USB for storage and input to a computer.

To order these products, please contact BTX at 800-272-2775 (US) or 508-893-8999 (outside the US) or techsupport.btx@harvardapparatus.com or visit www.btxonline.com to get complete list of distributors in your area.
MicroJect 1000 Max System

Balance Pressure
It’s all about the balance of pressure with our MicroJect 1000 MAX system. The unique “Balance” feature provides a secondary balance pressure to maintain positive pressure on the injection pipette. This is important before and after injections to avoid the chance of dilution of sample due to capillary action. It also prevents clogging of your injection needle.

Accessories
The MicroJect 1000 MAX system provides the “MAX”imum potential for your microinjection applications. The durability and precision of the MJ 1000 is coupled with two footswitches for easy operation of the Clear/Fill features. The system also includes two pipette holders and the appropriate adaptors.

Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Gas Pressure</td>
<td>70 to 105 p.s.i. (480 to 720 kPa)</td>
</tr>
<tr>
<td>Injection Pressure</td>
<td>0.2 to 60 p.s.i. (413 kPa), regulated, multi-turn control</td>
</tr>
<tr>
<td>Balance Pressure</td>
<td>0.1 to 3.5 p.s.i. (68.9 kPa), regulated, multi-turn control, other ranges available upon request</td>
</tr>
<tr>
<td>Fill Vacuum</td>
<td>Internally produced, -12.0 p.s.i. (-82 kPa), unregulated</td>
</tr>
<tr>
<td>Holding Vacuum</td>
<td>Internally produced, 0 to 3 in H2O (0 to 0.75 kPa or 0 to 0.1 p.s.i.), regulated</td>
</tr>
<tr>
<td>Clearing Pressure</td>
<td>Input gas pressure, unregulated</td>
</tr>
<tr>
<td>Injection Timer</td>
<td>0.01 to 0.99 sec in 10 msec steps; 1 to 99 sec in Pulse Width 1 sec steps</td>
</tr>
<tr>
<td>Injection Count Display</td>
<td>Digital, 0 through 9999</td>
</tr>
<tr>
<td>Duration Mode</td>
<td>Internally timed or externally gated</td>
</tr>
<tr>
<td>Time Trigger</td>
<td>Front panel, foot switch, or external TTL pulse (BNC)</td>
</tr>
<tr>
<td>Pressure Units</td>
<td>p.s.i./kPa; switch selectable</td>
</tr>
<tr>
<td>Pressure Monitor</td>
<td>BNC connector, 10 ml/p.s.i.</td>
</tr>
<tr>
<td>Pressure Readout</td>
<td>Inject, balance, clear, output port</td>
</tr>
<tr>
<td>Line Voltage</td>
<td>100/110/220/240 VAC</td>
</tr>
<tr>
<td>Power Usage</td>
<td>220 W</td>
</tr>
<tr>
<td>Meter Accuracy</td>
<td>0.1% full scale</td>
</tr>
<tr>
<td>Foot Switches</td>
<td>Inject, fill, hold, and gated; provided in Plus and Deluxe pkgs.</td>
</tr>
<tr>
<td>Weight</td>
<td>6.8 kg (15 lb)</td>
</tr>
<tr>
<td>Dimensions, H x W x D</td>
<td>11 x 38 x 25.5 cm (5 x 15 x 10 in)</td>
</tr>
<tr>
<td>Accessories Supplied</td>
<td>Input, output and holding hoses</td>
</tr>
</tbody>
</table>

Pressure Control Features

- Fill/Clear/Hold

The MicroJect 1000 Max provides key pressure features designed to maximize your injection potential with two negative and three positive pneumatic capabilities. The negative pressure feature or vacuum function allows researchers the ability to fill the micropipettes from their tips. The “Fill” feature reduces waste of valuable injection material. The “Hold” feature provides the means to immobilize and manipulate a cell or oocyte using a micropipette. The positive pressure feature allows for the precise discharge of fluids by simply using the “Clear” function of the system.

Applications

- Nuclear Transfer Applications
- Transgenic Animal Development
- Injection of Mouse, Xenopus, Zebrafish and other oocytes
- Intra-cytoplasmic sperm injection
- Cell injection
- Extracellular brain injections
- Injection of DNA, mRNA, microbeads neurotransmitters, kinases and other proteins

The NEW MicroJect 1000 MAX (MJ 1000) is the newest addition to our family of BTX transfection products. The MJ 1000 MAX microinjection system provides reliable, consistent and precise delivery of volumes through stable pressure regulation. The compressed gas internally controlled pressure system, allows the precise delivery of desired volumes ranging from femtoliters to microliters and efficiently. This microinjection system provides a reliable, consistent and precise delivery of volumes through stable pressure regulation. The MJ 1000 MAX is capable of holding a cell, oocyte or early stage embryo stationary while simultaneously using a separate pressure channel for injections. The MJ 1000 MAX is versatile enough to provide the same consistent performance needed to inject large volumes into tissue such as capillaries, or pico volumes, for nuclear injections. It is also ideal for the gentle transfer of delicate fetal or stem cells into oocytes.
### Generator Specifications

#### Applications
- ECM® 830: Mammalian Cell Transfection, Intact Plant Tissue and Protoplast Transformation, In Vivo and In Vitro Protein/Drug/Gene Delivery, In Ovo Nuclear Transfer and Embryo Manipulation, Limited Bacterial and Yeast Transformations
- ECM® 2001: Cell Fusion, Nuclear Transfer, Embryo Manipulation, Mammalian Transfection, Hybridoma Production, In Vivo Protein/Drug/Gene Delivery, Plant Protoplast Fusion, Limited Bacterial and Yeast Transformations

#### Waveform
- ECM® 830: Square
- ECM® 2001: Square

#### AC Ranges
- **Proprietary Non-Sinusoidal Wave Shape:**
  - Frequency: N/A 1 MHz
  - Voltage: N/A 0 to 75 V RMS
  - Duration: N/A 0 to 99 sec
  - Amplitude Post Fusion: N/A 1/10 of alignment current
  - Pause Between AC/DC: N/A 50 µsec

#### DC Pulse Ranges
- **Voltage Range:**
  - LV Mode: 5 to 500 V / 1 V resolution
  - HV Mode: 505 to 3,000 V / 5 V resolution
- **Pulse Length Range:**
  - LV Mode: 10 µsec to 999 µsec / 1 µsec resolution 0.01 to 0.99 msec / 0.01 msec resolution
  - LV Mode: 1 sec to 10 sec / 0.1 sec resolution
  - HV Mode: 10 to 600 µsec / 1 µsec resolution 1 to 99 µsec / 1 µsec resolution

#### Voltage Dependent/Internally Controlled
- **Multiple Pulsing:**
  - 1 to 99
- **Pulse Interval:**
  - 100 msec to 10 sec / 1 µsec resolution
- **No. Cycle Repeats:**
  - N/A 0 to 9 cycles
- **Programmability:**
  - Storage for 3 parameters (V, t, n, interval)
- **Arc Control:**
  - Arc Quenching™

#### Capacitance in Micro Farads:
- **LV:** 4,000 µF
- **HV:** 111 µF

#### Internal Resistance (in parallel with load) Ω
- **LV:** 56 Ω
- **HV:** 56 Ω

#### Other Specifications
- **Operational Status:**
  - Internal self test upon start-up
- **Interface:**
  - Digital User Interface
- **Input:**
  - 100 to 240 VAC, 50/60 Hz
- **Charge Time:**
  - 5 sec maximum (without delay)
- **Display:**
  - 4 line x 20 character LCD
- **Controls:**
  - Single rotary knob with push button toggle to set parameters, On/Off Power and Start switches
- **Electroporation Chamber:**
  - Safety Stand or Plate Handler
- **Monitoring:**
  - Monitoring and display of V, t, n, interval
- **HT (High Throughput) Multi-Well 96 or 25:**
  - Compatible
- **Remote Operation:**
  - Footswitch available
- **CE Marking:**
  - Yes
- **Dimensions (H x W x D):**
  - 14 x 31.8 x 31.1 cm (5.5 x 12.5 x 12.25 in)
  - 27.9 x 43.2 x 39.4 cm (11 x 17 x 15.5 in)
- **Weight:**
  - 6.8 kg (15 lbs)
  - 21.3 kg (47 lbs)
- **Warranty:**
  - 2 Years
- **See Page:**
  - Page 22

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**Contact Information:**
- Toll free: 800.272.2775
- Local: 508.893.8999
- www.btxonline.com
### Applications

<table>
<thead>
<tr>
<th>ECM® 630</th>
<th>ECM® 399</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria and Yeast Transformations, Plant Protoplast and Intact Plant Tissue Transformation, In Vitro Protein/Drug/Gene Delivery, Mammalian Transfections</td>
<td>Bacteria and Yeast Transformations, Limited Mammalian Transfections</td>
</tr>
</tbody>
</table>

### Waveform

- Exponential Decay (ECM® 630)
- Exponential Decay (ECM® 399)

### AC Ranges

Proprietary Non-Sinusoidal Wave Shape:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ECM® 630</th>
<th>ECM® 399</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Voltage</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Duration</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Amplitude Post Fusion</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Pause Between AC/DC</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### DC Pulse Ranges

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ECM® 630</th>
<th>ECM® 399</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Range:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV Mode</td>
<td>10 to 500 V / 1 V resolution</td>
<td>2 to 500 V / 2 V resolution</td>
</tr>
<tr>
<td>HV Mode</td>
<td>50 to 2,500 V / 5 V resolution</td>
<td>10 to 2,500 V / 10 V resolution</td>
</tr>
<tr>
<td>Voltage Range:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV Mode</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>HV Mode</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Pulse Length Range:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV Mode</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>HV Mode</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Voltage Dependent/Internally Controlled

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ECM® 630</th>
<th>ECM® 399</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Pulsing</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Pulse Interval</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>No. Cycle Repeats</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Programmability</td>
<td>Storage for 2 parameters (V, t, n, interval)</td>
<td>N/A</td>
</tr>
<tr>
<td>Arc Control</td>
<td>Arc Quenching™</td>
<td>Arc Quenching™</td>
</tr>
<tr>
<td>Safety</td>
<td>Generator is short circuit proof</td>
<td>Generator is short circuit proof</td>
</tr>
</tbody>
</table>

### Capacitance in Micro Farads:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ECM® 630</th>
<th>ECM® 399</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV</td>
<td>1 µF, 25 µF to 3,275 µF</td>
<td>1,050 µF</td>
</tr>
<tr>
<td>HV</td>
<td>25 µF and 50 µF</td>
<td>36 µF</td>
</tr>
</tbody>
</table>

### Internal Resistance (in parallel with load) Ω

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ECM® 630</th>
<th>ECM® 399</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV</td>
<td>25 Ω to 1,575 Ω / 25 Ω resolution &quot;None&quot; setting to simulate alternative systems lacking resistance.</td>
<td>150 Ω</td>
</tr>
<tr>
<td>HV</td>
<td>25 Ω to 1,575 Ω / 25 Ω resolution</td>
<td>150 Ω</td>
</tr>
</tbody>
</table>

### Other Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>ECM® 630</th>
<th>ECM® 399</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Status</td>
<td>Internal self test upon start-up</td>
<td>Internal self test upon start-up</td>
</tr>
<tr>
<td>Interface</td>
<td>Digital User Interface</td>
<td>Digital User Interface</td>
</tr>
<tr>
<td>Input</td>
<td>100 to 240 VAC, 50/60 Hz</td>
<td>100 to 240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>Charge Time</td>
<td>5 sec maximum (without delay)</td>
<td>5 sec maximum (without delay)</td>
</tr>
<tr>
<td>Display</td>
<td>4 line x 20 character LCD</td>
<td>1 line x 16 character LCD</td>
</tr>
<tr>
<td>Controls</td>
<td>Single rotary knob with push button toggle to set parameters, On/Off Power and Start switches</td>
<td>Single rotary knob with push button toggle to set parameters, On/Off Power and Start switches</td>
</tr>
<tr>
<td>Electroporation Chamber</td>
<td>Safety Stand</td>
<td>PEP or Safety Stand</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Monitoring and display of V, t, n, interval</td>
<td>Monitoring and display of Voltage</td>
</tr>
<tr>
<td>HT (High Throughput)</td>
<td>Compatible</td>
<td>N/A</td>
</tr>
<tr>
<td>Multi-Well 96 or 25</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Remote Operation</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>CE Marking</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Dimensions (H x W x D)</td>
<td>14 x 31.8 x 31.1 cm (5.5 x 12.5 x 12.25 in)</td>
<td>10.9 x 23.1 x 19.6 cm (4.3 x 9.1 x 7.7 in)</td>
</tr>
<tr>
<td>Weight</td>
<td>4.5 kg (10 lbs)</td>
<td>3.2 kg (7 lbs)</td>
</tr>
<tr>
<td>Warranty</td>
<td>2 Years</td>
<td>2 Years</td>
</tr>
<tr>
<td>See Page</td>
<td>Page 21</td>
<td>Page 20</td>
</tr>
</tbody>
</table>
Efficient Electroporation Transfection
High efficiency transfection of the cell lines and previously considered “hard to transfect” cells.

High Cell Viability
Low toxicity resulting in improved cell viability.

Single Buffer for all Cell types
One buffer used in place of standard electroporation buffers for all mammalian cell types.

Control
Versatility of choosing your electroporation optimization settings for the highest transfection efficiency with BTX systems.

Affordability
Choose your size kit to fit your needs, more samples per kit with lower cost compared to competitor.

NEW! BTXpress™ High Performance Electroporation Solution
BTX, the electroporation experts, are introducing the NEW BTXpress™ High Performance Electroporation Solution. The BTXpress™ is THE solution in High Performance Electroporation. A single buffer solution developed to quickly and efficiently deliver genes into mammalian cells that were previously considered “hard to transfect” by chemical and other non-viral methods. This solution, in combination with the BTX electroporation instruments, provides researchers with the versatility and success desired with a broad range of cell types while maintaining critical cell viability. Transfection using this high performance electroporation solution is equally effective in delivering DNA as well as siRNA into mammalian cells. BTXpress™ solution is the first electroporation reagent that meets all of your high performance transfection needs without sacrificing control over your experiment or your budget. The BTXpress™ solution offers increased numbers of transfections per kit compared to our competitors providing higher value to the researcher. As a universal solution, the BTXpress™ electroporation solutions can be used in other electroporators including the Amaxa™ to deliver similar results without the typical high cost associated with these buffer kits. The BTXpress™ High Performance Electroporation Solution is offered as a kit including the BTX plus cuvettes with transfer pipettes or as a buffer alone.
### BTXpress™ Kits

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0803</td>
<td>BTXpress Solution Kit 50 Reactions in 2mm gap Cuvettes: Includes 5.0ml bottle BTXpress Solution and 5 bags of (10 cuvettes per bag), 2mm gap BTXplus cuvettes with transfer pipette.</td>
</tr>
<tr>
<td>45-0804</td>
<td>BTXpress Solution Kit 20 Reactions in 4mm gap Cuvettes: Includes 5.0ml bottle BTXpress Solution and 2 bags of (10 cuvettes per bag) 4mm gap BTXplus cuvettes with transfer pipette.</td>
</tr>
<tr>
<td>45-0806</td>
<td>BTXpress Solution Kit 100 Reactions in 2mm gap Cuvettes: Includes a 10ml bottle of BTXpress Solution and 2 bags of 50 cuvettes per bag, 2mm gap BTXplus cuvettes with transfer pipette.</td>
</tr>
<tr>
<td>45-0807</td>
<td>BTXpress Solution Kit 40 Reactions in 4mm gap Cuvettes: Includes a 10ml bottle of BTXpress solution and 4 bags of (10 cuvettes per bag) 4mm gap BTXplus cuvettes with transfer pipette.</td>
</tr>
</tbody>
</table>

### BTXpress™ Solution Only

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0802</td>
<td>BTXpress Solution: 5.0 ml Bottle for up to 50 Reactions</td>
</tr>
<tr>
<td>45-0805</td>
<td>BTXpress Solution: 10 ml Bottle for up to 100 Reactions</td>
</tr>
</tbody>
</table>

**Please Note:** Amaxa™ Nucleofector™ are registered trademarks. Use of this product is covered under patents and patents pending. This product is sold under license from Mirus® Bio LLC and its use is limited solely for research purposes.

Visit the BTX website for hundreds of protocols and publications

www.btxonline.com

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**Figure 1:** BTXpress™ High Performance Electroporation Solution vs. Amaxa™ Nucleofector™. Cells were electroporated with an EGFP reporter vector in parallel, using the BTX ECM 830 Square Wave Electroporator with the BTXpress™ High Performance Electroporation Solution or using the Amaxa (Lonza) system. EGFP expressing cells were identified 24hrs post-electroporation by flow cytometry and presented as a percentage of the live cell population.

**Figure 2:** BTXpress™ Solution Transfection Efficiency vs. Amaxa™: Cells were electroporated in parallel with an EGFP reporter vector using either the BTX electroporation system with BTXpress™ High Performance Electroporation Solution or PBS. In comparison to the same cells transfected in the Amaxa™ (Lonza) system using the Amaxa™ kit V solution. The EGFP expressing cells were identified 24 hrs post-electroporation by flow cytometry and presented as a percentage of the live cell population.

**Storage Conditions**

Store BTXpress™ Electroporation Solution at 4°C. Store all other components at room temperature. Components: Kits contain BTX plus cuvettes either 2mm gap or 4mm gap with transfer pipette.

---

Please Note: Amaxa™ Nucleofector™ are a registered trademarks.
Safety Stand and Disposable Cuvettes

The BTX Safety Stand is specially designed to connect to any BTX Generator allowing for the safe delivery of HV electrical pulses to cuvettes. Up to two cuvettes may be electroporated in the safety stand simultaneously. Each BTX Cuvette Plus includes a transfer pipette for the fast and easy removal of samples. The cuvette and pipette are packaged together and are gamma irradiated for sterility.

The cuvette caps are round for easy, one-handed removal and are color coded for quick identification.

The BTX Cuvette Rack holds up to 20 cuvettes in numbered positions.

Footswitch

The Footswitch allows for hands free operation of the ECM 830 and ECM 2001 Generators. This accessory is desirable when conducting in vivo / in ovo gene delivery or nuclear transfer/cloning when both hands are needed for sample manipulation.

The footswitch functions as the start button on the front of the generator.

Two types of Footswitches are available, the 1250SF model for the ECM 830 and the 2001FS model for ECM 2001 generator. Please call BTX technical support for information regarding compatibility with older models.

BTX Cuvettes Plus

(Individually packaged cuvettes with sterile transfer pipette)

<table>
<thead>
<tr>
<th>Item #</th>
<th>Gap Size</th>
<th>Package</th>
<th>Volume</th>
<th>Color</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0124</td>
<td>1 mm</td>
<td>50 each</td>
<td>20 – 90 µl</td>
<td>Gray</td>
<td>Bacterial</td>
</tr>
<tr>
<td>45-0125</td>
<td>2 mm</td>
<td>50 each</td>
<td>40 – 400 µl</td>
<td>Blue</td>
<td>Bacterial, Mammalian</td>
</tr>
<tr>
<td>45-0126</td>
<td>4 mm</td>
<td>50 each</td>
<td>80 – 800 µl</td>
<td>Yellow</td>
<td>Mammalian</td>
</tr>
</tbody>
</table>

BTX Safety Stand, Cuvette Rack & Footswitch

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0207</td>
<td>Safety Stand for use w/BTX Generator and BTX Cuvette Plus (Model 630B)</td>
</tr>
<tr>
<td>45-0208</td>
<td>Cuvette Rack, 20 Position (Model 660)</td>
</tr>
<tr>
<td>45-0211</td>
<td>Footswitch for ECM 830 (Model 1250FS)</td>
</tr>
<tr>
<td>45-0086</td>
<td>Footswitch for ECM 2001 (Model 2001FS)</td>
</tr>
</tbody>
</table>

BTX Bulk Case Cuvettes

(Case contains 24 packs of 100 Cuvettes each)

<table>
<thead>
<tr>
<th>Item #</th>
<th>Gap Size</th>
<th>Package</th>
<th>Volume</th>
<th>Color</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0140</td>
<td>1 mm</td>
<td>2400 each</td>
<td>20 – 90 µl</td>
<td>Gray</td>
<td>Bacterial</td>
</tr>
<tr>
<td>45-0141</td>
<td>2 mm</td>
<td>2400 each</td>
<td>40 – 400 µl</td>
<td>Blue</td>
<td>Bacterial, Mammalian</td>
</tr>
<tr>
<td>45-0142</td>
<td>4 mm</td>
<td>2400 each</td>
<td>80 – 800 µl</td>
<td>Yellow</td>
<td>Mammalian</td>
</tr>
</tbody>
</table>

• Safety Stand and Cuvettes protect both the user and sample
• Cuvettes are compatible with most commercially available Electroporators
• Sterile Transfer Pipette included with every cuvette Plus package, allowing quick and easy removal of each sample
• Three cuvette sizes: 1 mm, 2 mm and 4 mm, are available to suit all applications
• Round, cuvette caps allow for single-hand removal and are color coded for easy recognition
Genetrodes™
In Vivo, Ex Vivo & In Ovo Electroporation

Applications

- In Vivo Gene Delivery
- Ex Vivo Gene Delivery
- In Ovo Gene Delivery

BTX Genetrodes are paired, reusable, needle-style or L-shaped type electrodes that are ideal for in vivo and in ovo electroporation applications, including drug and gene delivery. Genetrodes come in five models to suit the size and shape of the target electroporation area. Each model consists of a pair of electrodes configured as either straight or bent L-shaped electrodes with gold tips.

The electrodes are placed into target tissue following injection of the molecule of interest. An electroporation pulse is then delivered using a BTX Generator. The electric field introduced by the Genetrodes causes transient pores to form in the cells of the tissue, allowing uptake of the molecules into cells. Genetrodes are positioned in parallel at a predetermined gap in tissue using the Genetrode/Genepaddle Holder.

Specifications

Generator Compatibility: ECM 830, ECM 2001
Voltage Range: 0 – 200 V DC
Pulse Length Range: 10 µsec – 99 msec
Diameter: Electrode tip 0.5 mm
Genetrode Holder:
  - Electrode Gap: 1 – 10 mm range
  - Life Span: Approximately 1500+ pulses

Genetrodes*

<table>
<thead>
<tr>
<th>Item #</th>
<th>Tip Size</th>
<th>Shape</th>
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</thead>
<tbody>
<tr>
<td>45-0113*</td>
<td>5 mm</td>
<td>Straight</td>
</tr>
<tr>
<td>45-0114*</td>
<td>10 mm</td>
<td>Straight</td>
</tr>
<tr>
<td>45-0115*</td>
<td>5 mm</td>
<td>L-Shaped</td>
</tr>
<tr>
<td>45-0116*</td>
<td>3 mm</td>
<td>L-Shaped</td>
</tr>
<tr>
<td>45-0117*</td>
<td>1 mm</td>
<td>L-Shaped</td>
</tr>
</tbody>
</table>

Genetrode Kits**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Tip Size</th>
<th>Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0160**</td>
<td>5 mm</td>
<td>Straight</td>
</tr>
<tr>
<td>45-0161**</td>
<td>10 mm</td>
<td>Straight</td>
</tr>
<tr>
<td>45-0162**</td>
<td>5 mm</td>
<td>L-Shaped</td>
</tr>
<tr>
<td>45-0163**</td>
<td>3 mm</td>
<td>L-Shaped</td>
</tr>
<tr>
<td>45-0164**</td>
<td>1 mm</td>
<td>L-Shaped</td>
</tr>
</tbody>
</table>

Genetrode Accessories

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0203</td>
<td>Genetrode/Genepaddle Holder (Model 515)</td>
</tr>
<tr>
<td>45-0216</td>
<td>Connection Cable, Micrograbber to Banana Plug Cable</td>
</tr>
<tr>
<td>45-0217</td>
<td>Banana to Banana Plug, 10ft.</td>
</tr>
<tr>
<td>45-0089</td>
<td>Adapter Set Banana to Square Post</td>
</tr>
<tr>
<td>45-0087</td>
<td>Adapter Micrograbber for ECM 2001</td>
</tr>
</tbody>
</table>

* Requires 45-0203 Genetrodes/Genepaddle Holder and 45-0216 Connection Cable
** Kit Includes Genetrode Electrode, 45-0203 Genetrodes/Genepaddle Holder and 45-0216 Connection Cable

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Tweezertrodes™
In Vivo Drug/Gene Delivery

Applications
• In Vivo Drug or Gene Delivery
• Ex Vivo Drug or Gene Delivery
• In Utero Drug or Gene Delivery

The Tweezertrodes™ are reusable, tweezer style electrodes for in vivo, and in utero drug or gene delivery. Tweezertrodes™ consist of a standard 12 cm tweezer that has been modified with stainless steel or platinum circular electrodes at the tip. The gap between the electrode disks may be adjusted from under 1 mm to over 2 cm. Stainless Steel Tweezertrodes are available in two sizes 10 mm and 7 mm diameters. Our NEW! Platinum Tweezertrodes™ are available in 7 mm, 5 mm, 3 mm and 1 mm diameters. These electrodes are connected to an electroporator with the Model 524 Connection Cable, and are compatible with the BTX ECM® 830 and ECM® 2001.

Specifications
Generator Compatibility
ECM 830, ECM 2001
Voltage Range
0 – 200 V DC (Do not use AC)
Pulse Length Range
10 µsec – 99 msec
Paddle Configuration
Rectangular, 1 mm thick
Gold Plating Thickness
0.04 mm
Genetrodge Holder
Electrode gap 1 – 10 mm range, life span (depending on care) approximately 200+ sets of pulses

Genepaddles™
In Vitro Embryo & In Vivo Gene Delivery

Applications
• In Vivo Gene Delivery
• Ex Vivo Gene Delivery

BTX Genepaddles are designed for in vivo applications such as Gene Delivery in mouse embryo. Genepaddles are non-invasive, paddle-style, reusable electrodes suitable for a variety of applications. These electrodes are gold plated and are available in two models, each model consisting of a pair of electrodes. The electrodes are placed anterior and posterior to the embryo following injection of the molecule of interest, and then an electroporation pulse is delivered using a BTX Generator. The Genepaddles may be positioned in parallel at a predetermined gap in tissue using the Genetrodge/Genepaddle Holder.

Specifications
Generator Compatibility
ECM 830, ECM 2001
Voltage Range
0 – 200 V
Pulse Length Range
10 µsec – 99 msec
Paddle Configuration
Rectangular, 1 mm thick
Gold Plating Thickness
0.04 mm
Genetrodge Holder
Electrode gap 1 – 10 mm range, life span (depending on care) approximately 200+ sets of pulses

Platinum & Stainless Steel Tweezertrodes™

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0118*</td>
<td>Stainless Steel Tweezertrode Electrode, 7 mm Diameter, no Cables (Model 520)</td>
</tr>
<tr>
<td>45-0165</td>
<td>Stainless Steel Tweezertrode Kit, 7mm, Includes Cable (Model 520KT)</td>
</tr>
<tr>
<td>45-0119*</td>
<td>Stainless Steel Tweezertrode Electrode, 10 mm Diameter, no Cables (Model 522)</td>
</tr>
<tr>
<td>45-0166</td>
<td>Stainless Steel Tweezertrode Kit, 10 mm, Includes Cable</td>
</tr>
<tr>
<td>45-0466</td>
<td>Platinum Tweezertrode, 1 mm Diameter, Includes Cables</td>
</tr>
<tr>
<td>45-0467</td>
<td>Platinum Tweezertrode, 3 mm Diameter, Includes Cables</td>
</tr>
<tr>
<td>45-0489</td>
<td>Platinum Tweezertrode, 5 mm Diameter, Includes Cables</td>
</tr>
<tr>
<td>45-0488</td>
<td>Platinum Tweezertrode, 7 mm Diameter, Includes Cables</td>
</tr>
<tr>
<td>45-0204</td>
<td>Tweezertrode Cables (Model 524)</td>
</tr>
</tbody>
</table>

* Requires 45-0203 Genetrodges/Genepaddle Holder and 45-0216 Connection Cable
** Kit Includes Genepaddle Electrode, 45-0203 Genetrodges/Genepaddle Holder and 45-0216 Connection Cable

* Needs cable 45-0204 to connect to generator

NEW!
2-Needle Array™
In Vivo Muscle Gene Therapy

Applications

• In Vivo Drug or Gene Delivery
• Muscle Gene Therapy

The BTX 2-Needle Array Electrodes are needle-style electrodes designed for in vivo drug or gene delivery applications. The electrode is available in two gap sizes, 5 mm and 10 mm. The 5 mm 2-Needle Array and Handle is recommended for small muscle masses such as mouse tibialis. The 10 mm 2-Needle Array and Handle is recommended for larger muscle masses such as rat gastrocnemius. Among the non-viral techniques for in vivo gene transfer, the direct injection of plasmid DNA into muscle is simple, inexpensive and safe.

These Electrodes are supplied in a convenient kit that includes one 2-Needle Array Handle and six 2-Needle Arrays. Components may also be purchased separately.

Specifications

Generator Compatibility
ECM 830, ECM 2001
Voltage Range
0 – 500 V
Pulse Length Range
10 µsec – 99 msec
Handle Length
8 cm (3.2 in)
Handle Material
Delrin
Needle Length
20 mm
Needle Material
Stainless Steel

2-Needle Array™ Electrode Kits

<table>
<thead>
<tr>
<th>Item #</th>
<th>Gap Size</th>
<th>Handle</th>
<th>2-Needle Array</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0168*</td>
<td>5 mm</td>
<td>1 each</td>
<td>Package 6, 5 mm gap</td>
</tr>
<tr>
<td>45-0167*</td>
<td>10 mm</td>
<td>1 each</td>
<td>Package 6, 10 mm gap</td>
</tr>
</tbody>
</table>

2-Needle Array™ Electrodes, pkg. of 6

<table>
<thead>
<tr>
<th>Item #</th>
<th>Gap Size</th>
<th>Package</th>
<th>Sterile</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0121**</td>
<td>5 mm</td>
<td>pkg 6</td>
<td>Yes</td>
</tr>
<tr>
<td>45-0120**</td>
<td>10 mm</td>
<td>pkg 6</td>
<td>Yes</td>
</tr>
</tbody>
</table>

2-Needle Array Handles Only

<table>
<thead>
<tr>
<th>Item #</th>
<th>For Gap Size</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>45-0206</td>
<td>5 mm</td>
<td>1 each</td>
</tr>
<tr>
<td>45-0205</td>
<td>10 mm</td>
<td>1 each</td>
</tr>
</tbody>
</table>

* Kit Includes 2-Needle Array Electrode and Handle with Cable
** Requires 2-Needle Array Handle with Cable

Visit the BTX website for hundreds of protocols and publications
www.btxonline.com
**Flat Electrode for Cell Fusion**

- **Cell Fusion**
- **Hybridoma Production**
- **Plant Protoplast Fusion**
- **Mammalian Cell Transfection**

The Flat Electrode can be used for both electroporation and electro cell fusion. The Flat Electrode generates either a divergent or homogeneous field depending on the orientation of the grooved electrodes.

The Flat Electrode can be oriented with the grooved sides of the electrode facing one another to generate a divergent field for use in electro cell fusion. Alternatively, it can be oriented with the flat sides facing each other providing a homogeneous field for electroporation.

The Electrode is made of two rectangular, parallel plates of high grade stainless steel that are press-fitted into a polysulfone base.

### Specifications

**Generator Compatibility**
- ECM 830, ECM 2001 and ECM 630

**Flat Electrode**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Gap Size</th>
<th>Package</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0108*</td>
<td>1 mm</td>
<td>1 each</td>
<td>0.5 ml</td>
</tr>
</tbody>
</table>

* Requires 45-0217 Connection Cable

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**Flatpack Chambers**

- **Applications**
  - Bacterial Transformation
  - Yeast Transformation
  - Stem Cell Transfection

Flatpack Chambers are primarily used for prokaryotic applications; however, they are used often for high efficiency stem cell transfection as well. The one of a kind flow-through construction of the 0.56 mm gap has a volume capacity from 10 to 85 µl. This design provides the unique combination of small sample volumes with field strengths as high as 40 kV/cm. The Flatpack Chamber 1.83 mm has a three-ply solid sandwich construction of stainless steel and mylar plastic holds a volume of 1.5 ml, ideal for stem cells. Flatpack chambers are gamma sterilized in individual packages. They are provided in sets of 50 and may be used in the Safety Stand.

### Specifications

**Generator Compatibility**
- ECM 830 and ECM 2001

**Field Type**
- Divergent or Homogeneous

**Autoclavable**
- No

<table>
<thead>
<tr>
<th>Item #</th>
<th>Gap Size</th>
<th>Package</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0109</td>
<td>1.83 mm</td>
<td>50 each</td>
<td>1.5 ml</td>
</tr>
<tr>
<td>45-0110</td>
<td>0.56 mm</td>
<td>50 each</td>
<td>80 µl</td>
</tr>
</tbody>
</table>

**Cable**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0217</td>
<td>Electrode Connection Cable, Banana to Banana, 10ft.</td>
</tr>
</tbody>
</table>

To order these products, please contact BTX at **800-272-2775** (US) or **508-893-8999** (outside the US) or **techsupport.btx@harvardapparatus.com** or visit **www.btxonline.com** to get complete list of distributors in your area.
Caliper Electrodes
In Vivo Transdermal/Muscle Gene
and Drug Delivery

Applications

• In Vivo Drug or Gene Delivery
• Transdermal Applications
• Intact Plant Applications

BTX Caliper Electrodes are reusable, caliper-style electrodes used for a variety of in vivo applications such as drug or gene delivery into muscle tissue, skin and whole organs. Caliper Electrodes consist of a caliper and a pair of plate electrodes.

Two models are available. The 45-0101 Calipers have 1 x 1 cm brass electrode plates and are used for smaller animals. The 45-0102 Calipers are supplied with two pairs of stainless steel electrode plates, 1.5 x 1.5 cm and 2 x 2 cm, and are used for larger surface areas. The Electrode plates on the caliper may be adjusted by using the roller mounted on the caliper.

The Electrodes clasp the target tissue area following injection of the molecule of interest. Electroporation pulses are then delivered using a BTX 830 or 2001 Generator. The electric field introduced by the Caliper Electrodes causes transient pores to form in the cells of the tissue, allowing uptake of the molecules into cells.

Visit the BTX website for hundreds of protocols and publications
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Specifications

<table>
<thead>
<tr>
<th>Generator Compatibility</th>
<th>ECM 830, ECM 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Range</td>
<td>0 – 500 V (depending on electrode gap)</td>
</tr>
<tr>
<td>Pulse Length Range</td>
<td>10 µsec – 99 msec (multiple pulsing permitted)</td>
</tr>
<tr>
<td>Electrode Gap</td>
<td>0.1 to 13 cm</td>
</tr>
<tr>
<td>Electrode Dimensions</td>
<td>1 x 1 cm brass or 1.5 x 1.5 cm and 2 x 2 cm stainless steel</td>
</tr>
</tbody>
</table>

Caliper Electrodes

<table>
<thead>
<tr>
<th>Item #</th>
<th>Plate Dimensions</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0101</td>
<td>1 x 1 cm</td>
<td>Brass</td>
</tr>
<tr>
<td>45-0102</td>
<td>1.5 x 1.5 cm and 2 x 2 cm</td>
<td>Stainless Steel</td>
</tr>
</tbody>
</table>
**Applications**

- **Mammalian Cell Transfections, Gene Therapy, Protein or Drug Delivery**
- **Plant/Yeast Applications**

The Petri Pulser is designed for the electroporation of adherent cells in situ or as an alternative to cuvette electroporation for larger cell suspensions volumes. The electroporation of adherent cells avoids the need for chemical dissociation of cells and eliminates the problems associated with low plating efficiencies following electroporation, interruption of cell cycles and intercellular communications.

To perform electroporation, simply add the exogenous molecule of interest into the electroporation buffer. The buffer can range in volume from 1.0 ml to 3.0 ml and is added to the cells grown in the plate. The electrode is lowered into the well plate containing the sample and then pulsed.

The Petri Pulser is designed to be reusable and fits into a single well of a 6-well plate or in an individual 35 mm dish. It consists of 13 gold plated electrodes spaced 2 mm apart. The Petri Pulser can be used with most BTX Generators.

**Specifications**

<table>
<thead>
<tr>
<th>Generator Compatibility</th>
<th>ECM 830, ECM 630, ECM 399 and ECM 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse Length Range</td>
<td>1 µsec – 35 msec</td>
</tr>
<tr>
<td>Voltage Range</td>
<td>0 – 300 V</td>
</tr>
<tr>
<td>Volume Range</td>
<td>0.5 – 3.0 mls</td>
</tr>
<tr>
<td>Autoclavable</td>
<td>No</td>
</tr>
<tr>
<td>Field Type</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>Gap Size</td>
<td>2 mm</td>
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</tbody>
</table>

**Petri Pulser Electrode**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
<th>Volume</th>
<th>Electrode Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0130</td>
<td>Petri Pusher, 2 mm gap for 6-well or 35 mm Petri Dish (Model PP35-2P)</td>
<td>0.5 – 3.0 ml</td>
<td>Gold plated</td>
</tr>
</tbody>
</table>

**Applications**

- **Adherent Mammalian Cell Transfections**
- **Plant Tissue Cell Transfections**

The Petri Dish Electrode is designed to be used with a 100 mm petri dish that functions as the electroporation chamber. The Petri Dish Electrode is used to electroporate adherent cells or tissue grown in a petri dish.

To perform electroporation, simply add the exogenous molecule of interest into the electroporation buffer. The buffer can range in volume from 10 ml to 50 ml and is added to the cells grown in the plate. The electrode is lowered into the petri dish containing the sample and pulsed.

The electrode assembly has a 2 mm gap size. It contains parallel stainless steel electrodes which generate a homogeneous field. The Petri Dish Electrode is compatible with most BTX Generators.

**Specifications**

<table>
<thead>
<tr>
<th>Generator Compatibility</th>
<th>ECM 830, ECM 630 and ECM 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Range</td>
<td>0 – 2000 V</td>
</tr>
<tr>
<td>Volume Range</td>
<td>10 – 50 ml</td>
</tr>
<tr>
<td>Gap Size</td>
<td>2 mm</td>
</tr>
<tr>
<td>Autoclavable</td>
<td>No</td>
</tr>
<tr>
<td>Field Type</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>Pulse Length</td>
<td>10 µsec – 10 msec</td>
</tr>
</tbody>
</table>

**Petri Dish Electrode**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0100</td>
<td>Petri Dish Electrode, 2 mm Gap, for 100 mm Petri Dish (Model 366)</td>
</tr>
</tbody>
</table>
**Microslides**

**Applications**
- Hybridoma Production
- Cell Fusion
- Nuclear Transfer
- Embryo Manipulation
- Plant Protoplast Fusion
- Oocyte Transfections

BTX Microslides are used for cell fusion, plant protoplast fusion and embryo manipulation applications. They are available in 4 gap sizes, 0.5, 1.0, 3.2 and 10 mm. The 0.5 and 1.0 mm microslides produce a divergent field of energy ideal for efficient embryo fusion. While the 3.2 and 10 mm slides provide a homogenous field for high fusion rates of hybridoma cells. The Microslides are designed to easily fit on a microscope stage to allow easy observation of the alignment of cells during electrofusion.

The Microslides are composed of a glass slide and two strips of stainless steel (wire or bar) set in a plastic petri dish.

**Specifications**

<table>
<thead>
<tr>
<th>Generator Compatibility</th>
<th>ECM 830 and ECM 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Type:</td>
<td></td>
</tr>
<tr>
<td>45-0103 &amp; 45-0104</td>
<td>Divergent</td>
</tr>
<tr>
<td>45-0105 &amp; 45-0106</td>
<td>Homogeneous</td>
</tr>
<tr>
<td>Max Voltage</td>
<td>500 V</td>
</tr>
<tr>
<td>Autoclavable</td>
<td>No</td>
</tr>
</tbody>
</table>

**Meander Fusion Chamber**

**Applications**
- Cell Fusion
- Plant Protoplast Fusion

The BTX Meander Fusion Chamber is a novel microslide design which is specifically used for electro cell fusion. The Meander Fusion Chamber generates a divergent field and is used for fusion of mammalian cells, plant, yeast, fungi and microorganisms. This specialty electrode is constructed of a conductive metal alloy. It has two primary bars that are connected by many tiny fingerlike projections. These projections are spaced 0.2 mm apart. This electrode is mounted on a glass slide. It is designed for direct viewing of dimer formation during alignment while under a microscope.

**Specifications**

<table>
<thead>
<tr>
<th>Generator Compatibility</th>
<th>ECM 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Type:</td>
<td>Divergent</td>
</tr>
<tr>
<td>Max Voltage:</td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td>16 V (0 – peak)</td>
</tr>
<tr>
<td>DC</td>
<td>480 V</td>
</tr>
<tr>
<td>Gap Size</td>
<td>0.2 mm</td>
</tr>
<tr>
<td>Autoclavable</td>
<td>No</td>
</tr>
</tbody>
</table>

**Microslides**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0103†</td>
<td>Microslide*, 0.5 mm Gap, 20 µl, pkg. of 10*(Model 450)</td>
</tr>
<tr>
<td>45-0104†</td>
<td>Microslide*, 1.0 mm Gap, 40 µl, pkg. of 10*(Model 450-1)</td>
</tr>
<tr>
<td>45-0105†</td>
<td>Microslide*, 3.2 mm Gap, 650 µl, pkg. of 1*(Model 453)</td>
</tr>
<tr>
<td>45-0106†</td>
<td>Microslide*, 10 mm Gap, 2.0 ml, pkg. of 1*(Model 453-10)</td>
</tr>
<tr>
<td>45-0216</td>
<td>Connection Cable, Micrograbber to Banana Plug Cable</td>
</tr>
</tbody>
</table>

* Requires 45-0216 Micrograbber to Banana Plug Cable
† Requires 45-0087 Adapter Set for Connection to EMC 2001

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Platinum Needle L-Shaped Electrode

Applications

• Ex-Vivo Tissues Gene or Drug Delivery
• In Vivo Tissues Gene or Drug Delivery
• Nuclear Transfer

These NEW! needle style platinum electrodes are specifically designed for in vivo applications on the most fragile of tissue types, such as brain tissue. In vivo transfection of delicate brain tissue can be difficult to perform with out damage to the tissue. The ultra thin electrode enables pinpoint transfection for greater ease and efficiency in fragile or in accessible tissue. These electrodes are ideal for delivering the electrical pulses directly to oocytes or embryos for nuclear transfer fusion applications. Our L-shaped electrodes are available in 3 mm tip length in order to accommodate the most research needs in small animal models.

Specifications

Generator Compatibility: ECM 830, ECM 2001
Voltage Range: 0-100 Volts
Pulse Length Range: 10 µsec to 100 msec
Needle Lengths: 3 mm
Electrode Length: 3 mm
Electrode Material: Platinum

Platinum Needle L-Shaped Electrode

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0510*</td>
<td>Platinum Needle L-Shaped Electrode Kit, 3 mm, Includes Cables</td>
</tr>
<tr>
<td>45-0509†</td>
<td>Platinum Needle L-Shaped Electrode, 3 mm, Needle Electrode Only</td>
</tr>
<tr>
<td>45-0508</td>
<td>Micrograbber Adapter for Needle Electrode</td>
</tr>
<tr>
<td>45-0204</td>
<td>Banana Adapter Cables</td>
</tr>
</tbody>
</table>

* Requires 45-0508 and 45-0204 to Banana Adapter
† Also requires 45-0088 Adapter Set, female to female for ECM 2001

To order these products, please contact BTX at 800-272-2775 (US) or 508-893-8999 (outside the US) or techsupport.btx@harvardapparatus.com or visit www.btxonline.com to get complete list of distributors in your area.
Petri Dish Platinum Electrode for Tissues

Applications

• Ex-Vivo Tissues Gene or Drug Delivery

This NEW tissue chamber is specifically designed to handle ex-vivo tissue samples that are either larger than normal or have a unique shape making it difficult to transfect using other standard electrodes. Transfection of ex-vivo tissue samples is an efficient method to deliver genes and drugs to a wide range of tissue types including cornea, muscle and skin. With the use of this chamber, transfection is made simple and easy. The chambers are available in two widths; 15mm and 5mm to accommodate many tissue sample sizes. The reusable chamber is made of a lab grade Pyrex glass petri dish and two platinum electrodes embedded in an inert silicone, creating the rectangular chamber that provides a homogeneous field of energy for high efficiencies.

Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator Compatibility</td>
<td>ECM 830, ECM 2001</td>
</tr>
<tr>
<td>Voltage Range</td>
<td>0-200 Volts</td>
</tr>
<tr>
<td>Pulse Length Range</td>
<td>10 µsec to 100 msec</td>
</tr>
<tr>
<td>Dimensions:</td>
<td></td>
</tr>
<tr>
<td>Chamber 5mm:</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>8 mm</td>
</tr>
<tr>
<td>Width</td>
<td>5 mm</td>
</tr>
<tr>
<td>Depth</td>
<td>3 mm</td>
</tr>
<tr>
<td>Chamber 15mm:</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>10 mm</td>
</tr>
<tr>
<td>Width</td>
<td>15 mm</td>
</tr>
<tr>
<td>Depth</td>
<td>5 mm</td>
</tr>
</tbody>
</table>

Petri Dish Platinum Electrode for Tissues Kits

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0505</td>
<td>Petri Dish Platinum Electrode for Tissue Chamber Kit, 5 mm</td>
</tr>
<tr>
<td></td>
<td>Includes Glass Petri Dish with Tissue Chamber 5 mm, Glass Petri Lid and Micrograbber Cables*</td>
</tr>
<tr>
<td>45-0507</td>
<td>Petri Dish Platinum Electrode for Tissue Chamber Kit, 15 mm</td>
</tr>
<tr>
<td></td>
<td>Includes Glass Petri Dish with Tissue Chamber 15 mm, Glass Petri Lid and Micrograbber Cables*</td>
</tr>
</tbody>
</table>

Petri Dish Platinum Tissue Chamber

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0504*</td>
<td>Petri Dish Platinum Electrode, Chamber Only, 5 mm gap</td>
</tr>
<tr>
<td>45-0506*</td>
<td>Petri Dish Platinum Electrode, Chamber Only, 15 mm gap</td>
</tr>
</tbody>
</table>

Cables

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0216*</td>
<td>Micrograbber Cables (positive and negative)</td>
</tr>
</tbody>
</table>

* Cables required are not included

Visit the BTX website for hundreds of protocols and publications

www.btxonline.com
Petri Dish Platinum Electrode for Tissue Slices

Applications

- Ex-Vivo Tissues Gene or Drug Delivery

This NEW electrode is designed for delicate and/or difficult tissue transfection. Ex vivo electroporation is an efficient, effective method to introduce genes, drugs or any number of molecules into a tissue. A common application is mouse brain slice for studying neuronal development. This specialty electrode makes transfection quick and simple and is compatible with the BTX ECM 830 and ECM 2001 generators.

The electrode is comprised of two parts, the petri dish and wand. The petri dish contains a platinum electrode chamber to secure the tissue. The wand incorporates an identical shaped platinum electrode, which is placed over the chamber to complete electroporation. This sandwich configuration ensures a homogeneous field of energy for optimum transfection.

Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator Compatibility</td>
<td>ECM 830, ECM 2001</td>
</tr>
<tr>
<td>Voltage Range</td>
<td>0-100 Volts</td>
</tr>
<tr>
<td>Pulse Length Range</td>
<td>10 µsec to 100 msec</td>
</tr>
<tr>
<td>Chamber Depth</td>
<td>1mm</td>
</tr>
<tr>
<td>Electrode Material</td>
<td>Platinum</td>
</tr>
<tr>
<td>Wand Material</td>
<td>Platinum</td>
</tr>
<tr>
<td>Dimensions:</td>
<td></td>
</tr>
<tr>
<td>Dish Electrode:</td>
<td>10 mm x 10 mm x 1 mm</td>
</tr>
<tr>
<td></td>
<td>7 mm x 7 mm x 1 mm</td>
</tr>
<tr>
<td>Wand Electrode:</td>
<td>10 mm x 10 mm</td>
</tr>
<tr>
<td></td>
<td>7 mm x 7 mm</td>
</tr>
</tbody>
</table>

Petri Dish Platinum Electrode for Tissue Slices Kits

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0500*</td>
<td>Petri Dish Platinum Electrode for Tissue Slices Chamber Kit, 10 mm</td>
</tr>
<tr>
<td>45-0490*</td>
<td>Petri Dish Platinum Electrode for Tissue Slices Chamber Kit, 7 mm</td>
</tr>
</tbody>
</table>

* Kits include dish chamber, wand and cables

Petri Dish Platinum Electrode Chambers and Wands

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0501**</td>
<td>Petri Dish Platinum Electrode Chamber Only, 10 mm, negative</td>
</tr>
<tr>
<td>45-0491**</td>
<td>Petri Dish Platinum Electrode Chamber Only, 7 mm, negative</td>
</tr>
<tr>
<td>45-0502***</td>
<td>Platinum Electrode Wand Only, 10 mm, positive</td>
</tr>
<tr>
<td>45-0492***</td>
<td>Platinum Electrode Wand Only, 7 mm, positive</td>
</tr>
</tbody>
</table>

** Requires, 45-0502, 45-0503, 45-0504
*** Requires, 45-0501, 45-0503, 45-0504

Cables

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0503</td>
<td>Micro-Grabber Cable for Chamber, negative</td>
</tr>
<tr>
<td>45-0511</td>
<td>Single Adaptor Cable for Wand</td>
</tr>
</tbody>
</table>

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Cables & Adapters

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-0217</td>
<td>Black and red banana to banana cables 10ft in length. Used with flat electrode.</td>
</tr>
<tr>
<td>45-0465</td>
<td>The 25 well plate adaptor for plate handler HT 200 and HT 100.</td>
</tr>
<tr>
<td>45-0216</td>
<td>A pair of black and red micrograbber to banana plugs cables, 10ft length. Used for microslides, genetrodes, genepaddles and tissue petri dish.</td>
</tr>
<tr>
<td>45-0088</td>
<td>Black and Red female/female adaptors for banana plug cables.</td>
</tr>
<tr>
<td>45-0087</td>
<td>A pair of black and red micrograbber adaptors for banana plug cables. Used with cables 45-0217 and ECM 2001 coaxial banana plug cables for all micrograbber, genetrode, genepaddle and Tissue petri dish.</td>
</tr>
<tr>
<td>45-0089</td>
<td>A pair of red and black square post adapter to banana plugs cables. Used with cable 45-0217 and 45-0052 for connecting to genetrodes and genepaddles.</td>
</tr>
<tr>
<td>45-0083</td>
<td>A pair of coaxial to banana plug cables both black and red, 10ft long. Connector cables for the ECM 2001 unit.</td>
</tr>
<tr>
<td>45-0204</td>
<td>A pair of red and black adaptor banana plug cables for Tweezertrode electrodes.</td>
</tr>
</tbody>
</table>
Warranty Information

BTX/Harvard Apparatus warrants BTX ECM® Generators, and HT plate handlers for a period of 2 (two) years from the date of purchase, Enhancer 3000 models for a period of 1 (one) year from the date of purchase and all other accessories and electrodes for a period of 90 (ninety) days from the date of purchase. At its option, BTX/Harvard Apparatus will repair or replace the unit if it is found to be defective as to workmanship or materials. This warranty does not extend to any instrumentation which has been (a) subject-ed to misuse, neglect, accident or abuse, (b) repaired or altered by anyone other than BTX/Harvard Apparatus without BTX/Harvard Apparatus’ express and prior approval, (c) used in violation of instructions furnished by BTX/Harvard Apparatus. This warranty extends only to the original cus-tomer purchaser. Failure to use the Enhancer 3000 High Voltage Probe to connect a BTX ECM® Generator to an external digital oscilloscope for monitoring will result in the voiding of this warranty; connecting directly to the external monitoring equipment or modified monitoring setup will damage the Generator. **IN NO EVENT SHALL BTX/HARVARD APPARATUS BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.** Some states do not allow exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. **THERE ARE NO IMPLIED WAR-RANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR USE, OR OF ANY OTHER NATURE.** Some states do not allow this limitation on an implied warranty, so the above limitation may not apply to you. Without limiting the generality of the foregoing, BTX/Harvard Apparatus shall not be liable for any claims of any kind whatsoever, as to the equipment delivered or for non-delivery of equip-ment, and whether or not based on negligence. Warranty is void if the ECM® Generator is changed in any way from its original factory design or if repairs are attempted without written authorization by BTX/Harvard Apparatus. Warranty is void if parts, connections or cell fusion chambers not manufactured or approved by BTX/Harvard Apparatus are used with the BTX units.

If a defect arises within the warranty period, promptly con-tact BTX/Harvard Apparatus, 84 October Hill Road, Building 7, Holliston, Massachusetts, USA 01746-1388 using our toll free number **1-800-272-2775** (US Only) or **508-893-8999** (E-mail: techsupport.btx@harvardapparatus.com). **Goods will not be accepted for return unless an RMA (Returned Materials Authorization) number has been issued by our customer service department.** The cus-tomer is responsible for shipping charges. Please allow a reasonable period of time for completion of repairs or replacement and return. If the unit is replaced, the replace-ment unit is covered only for the remainder of the original warranty period dating from the purchase of the original device. This warranty gives you specific rights, and you may also have other rights, which vary from state to state.
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Bacteria & Yeast

Plants & Insects

Mammalian Cell Transfections

In Vitro, In Utero, In Ovo

Electrofusion

Microinjection