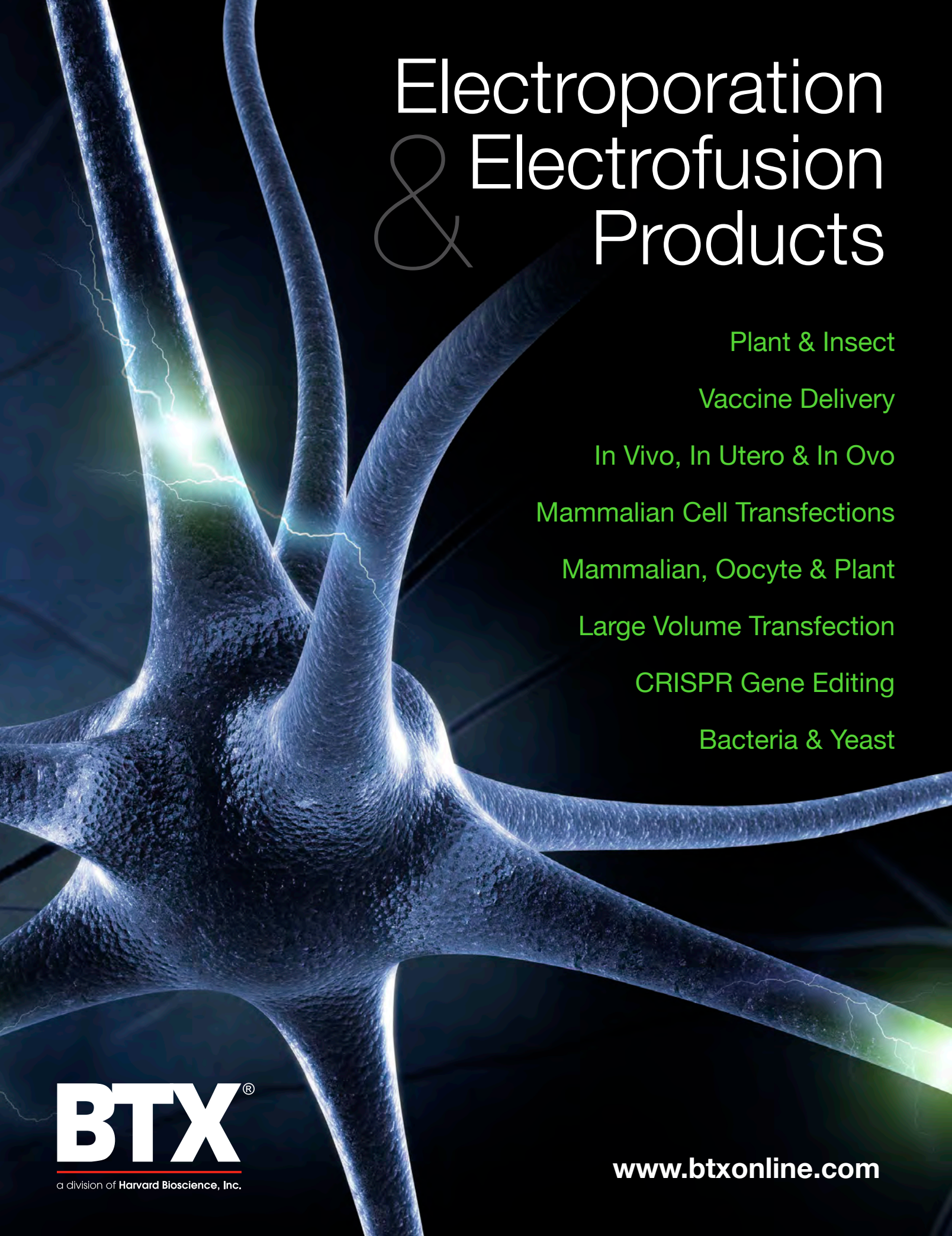
Electroporation
& Electrofusion
Products
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Vaccine Delivery
In Vivo, In Utero & In Ovo
Mammalian Cell Transfections
Mammalian, Oocyte & Plant
Large Volume Transfection
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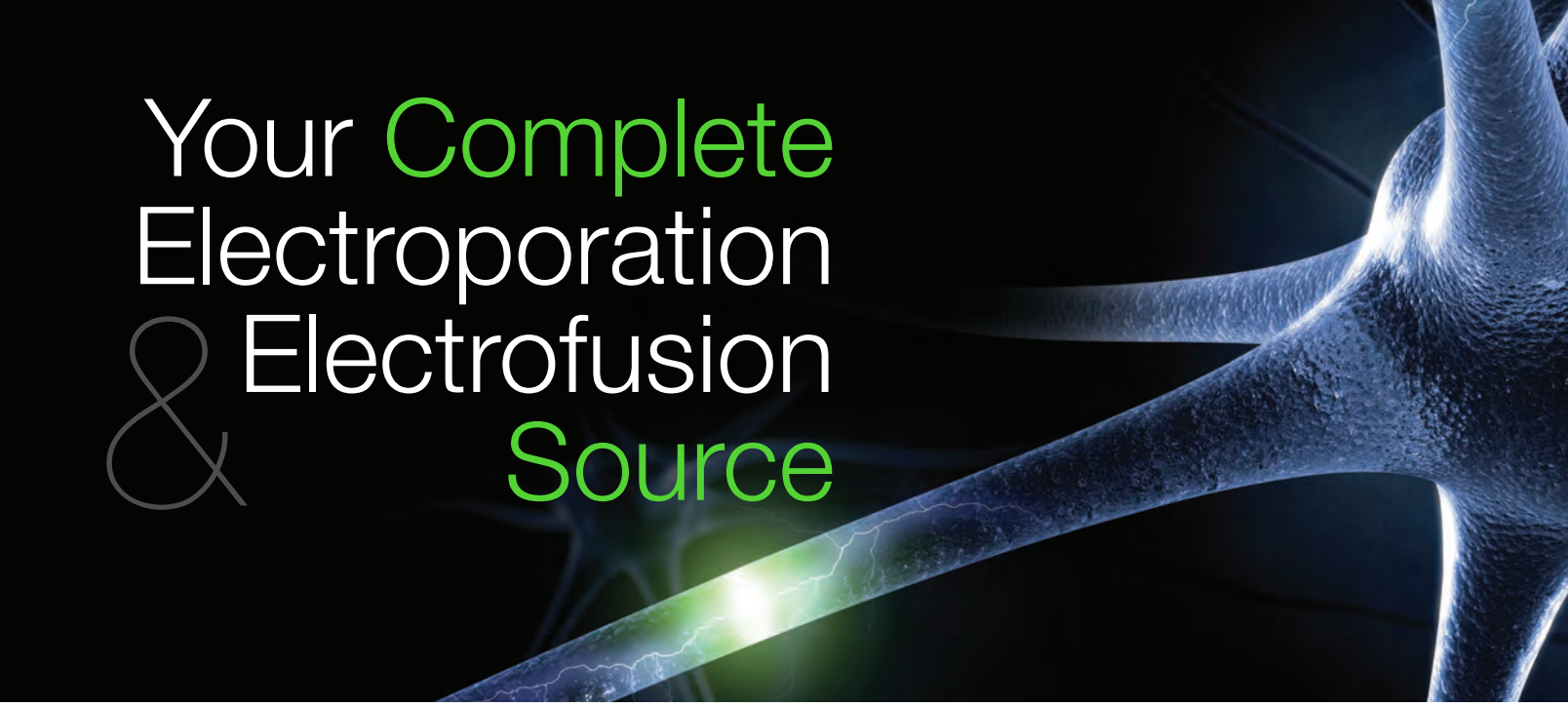

Your Complete Electroporation & Electrofusion Source

BTX has been at the forefront of electroporation technology since we introduced the first commercially available electroporator in 1983. For over 30 years, we have made it our priority to focus only on electroporation and electrofusion. This focus has allowed us to develop the experience and expertise to supply you with a broad selection of innovative in vivo and in vitro tools to advance your research.

Our range of electroporation systems and accessories cover virtually every application, including high throughput. Additionally BTX provides exceptional application support and service before, during, and after your purchase to ensure your success.

The BTX Advantage

Our comprehensive library of protocols and publications, along with the expertise of our technical staff, will make addressing your application needs easier. Thousands of users have published papers on many species, including mammals, bacteria, fruit flies, nematodes, chickens, frogs, muscles, liver, brains, embryos, and muscles, in vivo and in vitro.

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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 that are proximally located and 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 applications.

BTX®
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NOTE: *Products in this catalog are for Research Use Only. Not for use on humans unless proper investigational device regulations have been followed.*

Comprehensive Online Protocol Database

for Electroporation and Electrofusion Research visit:

btxonline.com/technical-resources/protocol-database.html

Search by system, cell type, transfectant, keyword, or citation

Reduce your application optimization time!

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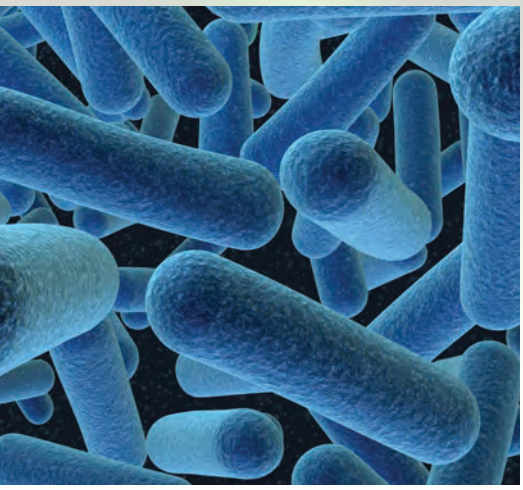
Applications

Explore this section to learn about the many applications for electroporation and electrofusion. BTX generally recommends a system that has an exponential decay waveform for bacteria, plant cells, insect cells, and yeast applications, and a square waveform for mammalian cell work.

Bacteria & Yeast

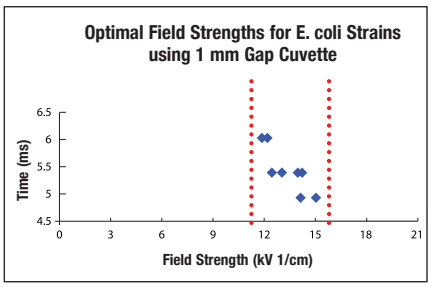


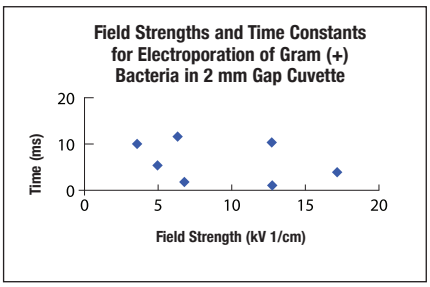
Electroporation is recognized as one of the most efficient methods of transforming human genes into prokaryotic cell lines. Researchers use this technique to express recombinant proteins to study gene function and for the therapeutic treatment of human diseases. Typically, the most commonly transformed cell lines are bacteria and yeast, such as *Escherichia coli*, *Agrobacterium tumerfaciens*, *Pichia pastoris,* and *Saccharomyces cerevisiae*. Electroporation of gram-negative bacterial strains can achieve transformation success rates in the range of $1x10^{10}$ transformants/µg 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 $1x10^{7}$ to $1x10^{10}$ transformants/µg DNA.

Other more difficult or less utilized microorganisms have also achieved significant positive transformation results with this method. These cell lines include anaerobic bacteria such as *Desulfovibro vulgaris*, *Dictoyostelium*, a cellular 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.

Typical Results





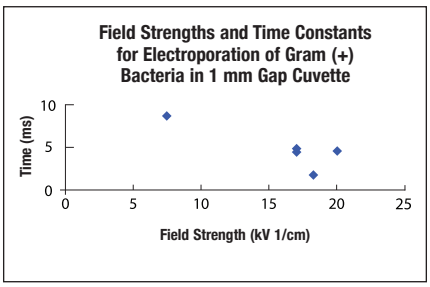


Figure 1: *Field strength and time constants for gram-negative bacteria in 1 mm gap cuvettes using the ECM 630 and 399 models. Field strengths and time constants remain grouped around discrete values. The ECM 630 would be a good choice for labs that are currently doing simple transformations now, but 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.*

Figures 2 and 3: *Field Strength and pulse duration values for gram-positive bacteria in 1 mm and 2 mm cuvettes. Unlike the gram-negative bacteria the field strengths and time constants are more variable with gram-positive. The ECM 630 is flexible and settings can be adjusted for optimizing multiple cell lines.*

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, ECM 630, and Gemini can attain the optimal voltage ranges up to 3000 V to provide field strengths of 12–30 kV/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 exponential decay wave pulse generators such as the ECM 399, ECM 630, and Gemini, 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 ms for efficient transformation of gram-negative bacteria and yeast. The ECM 630 and Gemini have 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 fixed internal resistance and capacitance settings which deliver the pre-optimized time constants of 5–6 ms in high voltage (HV) are ideal for the transformation of gram-negative bacteria. This system offers the best low-cost solution for simple transformation needs.

Prokaryotes and Eukaryotes Solution

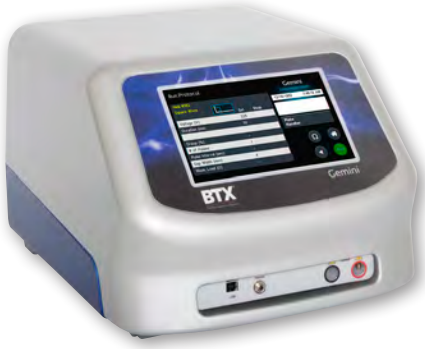
Labs working with a variety of bacterial and yeast strains often need to transfect mammalian cells as well. This requires more flexibility and control over the electrical parameters such as the voltage range and time constant for successful transfection. The ECM 630 and Gemini have been found to be efficient and the best instruments for select mammalian cell lines such as mouse stem cells.

High Throughput (HT) Solution

Not only are the Gemini X2 and the ECM 630 powerful stand-alone systems for transformation and transfection applications, but they are also capable of supporting a high throughput (HT) plate handler. The HT plate handler is an accessory which easily connects to the Gemini X2 or ECM 630 for the delivery of the powerful exponential wave pulse to electroporate 25- or 96-well electroporation plates in seconds. The HT multi-well system is an effective and affordable tool for optimizing electrical or biological parameters quickly and simply.

ECM™ 399
Exponential Decay Wave
Electroporation Generator

Gemini™
Twin Wave
Electroporation Generator



ECM™ 630
Exponential Decay Wave
Electroporation System

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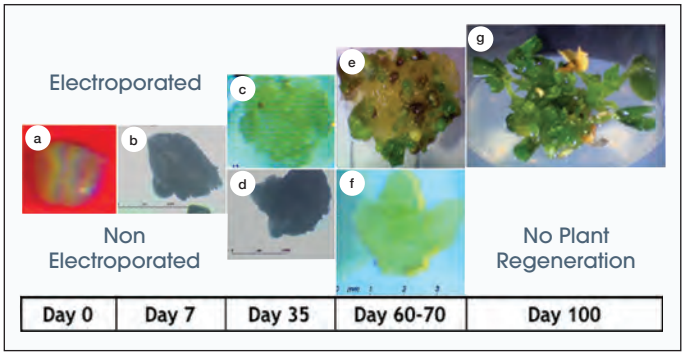
Plant & Insect Electroporation

For many years, agriculture and horticulture labs have used electroporation to transform plants in order to generate transgenic crops. 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 transgenically 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, enhancing 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 Gemini, 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 transecting 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.

Typical Results



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.

Ravinder Kaur Grewal, Monika Lulsdorf, Janine Croser, Sergio Ochatt, Albert Vanderberg, Thoma D. Warkentin,. Doubled-haploid Production in Chickpea Cicer arietinum L.): Role of Stress Treatments. Plant Cell Reports, 30, May, 2009

Plants

Stable or transient integration of genes into plant protoplast cells without modification of the cell wall can be performed with high viability using the BTX line of electroporation generators. Plant species such as wheat, barley leaf and root protoplasts have been transformed through optimized electroporation parameters on the BTX generators. The Gemini Twin Wave and ECM 630 exponential decay wave systems provide a wide scope of voltage settings (10 - 3000 V) resulting in field strengths up to 30 kV/cm and an array of possible time constants (pulse durations) critical for highly efficient electro-transformations.

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 protoplasts 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 waveforms to align cells for better membrane contact, fuse cells together and with post AC alignment continue 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. Newton Ruiz, et al. effectively utilized ECM 2001+ square wave electroporation as a non-invasive delivery method for dsRNA-mediated gene silencing in Rhipicephalus Microplus eggs and embryos. 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.

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 produced by the Gemini twin wave and ECM 830 generators. The square wave pulse generator provides the voltage ranges and multiple pulsing capabilities needed for efficient membrane permeation without sacrificing cell viability critical to these applications.

Field Strengths and Time Constants

The Gemini twin wave and ECM 630 exponential decay wave pulse generators have 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 transformations of difficult cell types including plant tissues and agrobacterium cells producing efficiencies of 1 x 10^8 pfu/µg.

ECM™ 630
Exponential Decay Wave Electroporation Generator

ECM™ 830
Square Wave Electroporation Generator

ECM™ 2001+
Square Wave Electrofusion and Electroporation Generator

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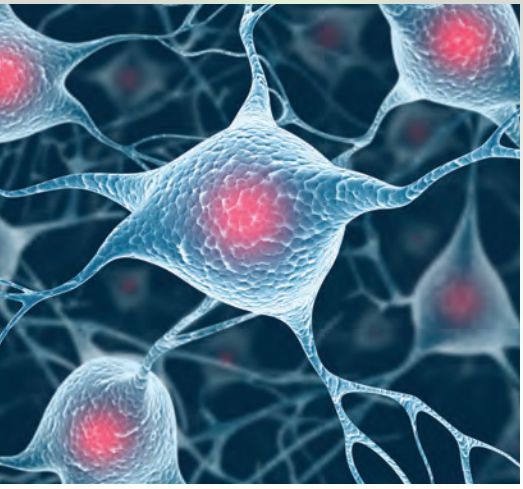
Ravinder Kaur Grewal, Monika Lulsdorf, Janine Croser, Sergio Ochatt, Albert Vanderberg, Thoma D. Warkentin,. Doubled-haploid Production in Chickpea Cicer arietinum L.): Role of Stress Treatments. *Plant Cell Reports,* 30, May, 2009

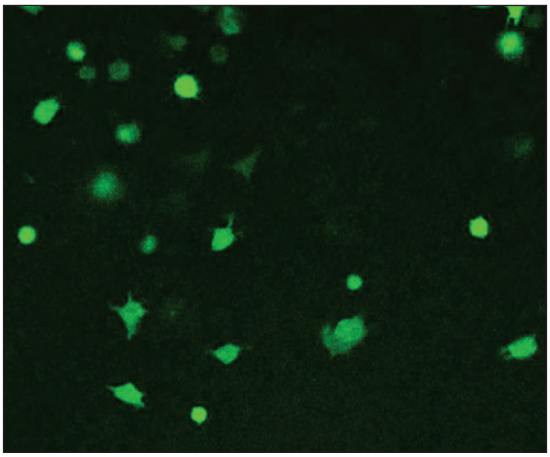
Mammalian Cell Transfection



Electroporation is an efficient non-viral method used to transfect genes and other molecules into mammalian cell lines. This technology is commonly used to study gene targeting, function and to understand protein regulation. Electroporation is a standard method used to transfect mammalian cell lines to express recombinant human proteins which are used for therapeutic purposes. Gene delivery by this method is typically used to create a transient transfection in order to study protein expression or to temporarily knockout or "silence" genes using siRNA. This is used to study gene targeting and function. Alternatively the stable transfection integrates the gene into the genome of the cell for long term expression of a human protein. The use of the square wave pulse generator ECM 830 and Gemini twin wave generator offer the control needed to adjust electrical settings for optimization of parameters.

These systems are powerful enough to yield high transfection efficiencies for cell lines and difficult to transfect cell types including stem cells and primary cells. The gentle square wave pulse allows for high cell viability of these cell types.

Typical Results



PC12 cells were transfected with eGFP plasmid DNA using the ECM 830 system. GFP expression was observed 48 hrs. post transfection. Courtesy of Anne Chiaramello, Ph.D Associate Professor, George Washington University Medical Center.

Mammalian Cell Transfection — "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 efficiencies and cell viability. With the Gemini and 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 systems that provide 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 (HT) 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.

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 with a 1 µs resolution, 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 or Gemini X2 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.

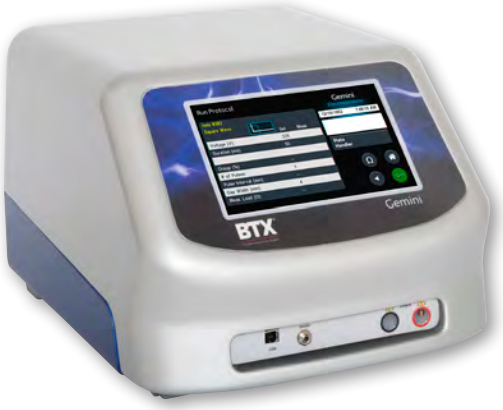
Gene Silencing

The use of technologies such as CRISPR/Cas9, siRNA, and morpholinos to analyze gene function are fundamental for research. The ECM 830 has been used successfully for these applications with inhibition and cell viabilities of up to 90%. Callif, et al. recently utilized a high-throughput method with the ECM 830, HT-200, and 96-well electroporation plates to successfully perform high-content loss-of-function screens of CRISPR/Cas9 knocked-down targets in primary neurons.

BTXpress™ High Performance Electroporation Solution

BTXpress® Electroporation Buffer is a single buffer developed to quickly and efficiently deliver genes into mammalian cells that were previously recalcitrant to chemical and non-viral methods. BTXpress supports high efficiency transfection in numerous cell types while maintaining critical cell viability. This high performance electroporation buffer is equally effective at delivering DNA as well as siRNA into mammalian cells. This buffer is not restricted to use in just BTX electroporation systems. As a universal solution, BTXpress Electroporation Buffer can be used in other systems including the Lonza Nucleofector™, achieving similar results.

ECM™ 830
Square Wave Electroporation Generator



Gemini
Twin Wave Electoporation Generator

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Please note: Nucleofector is a registered trademark of Lonza.

In Vivo, In Utero & In Ovo 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 as well as marine species such as zebrafish.

Typical Results

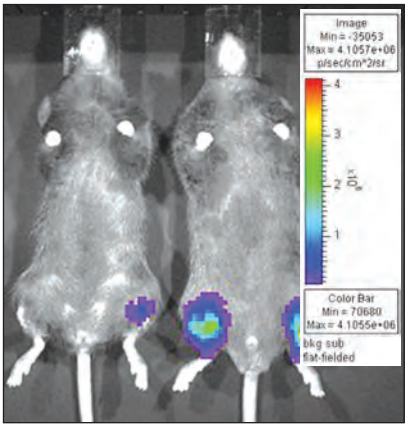


Figure 1: *Bioluminescence Imaging of Tibialis anterior muscles injected with a luciferase plasmid and electroporated compared to injection alone. Provided by Carmen Bertoni Ph.D, Department of Neurobiology UCLA.*

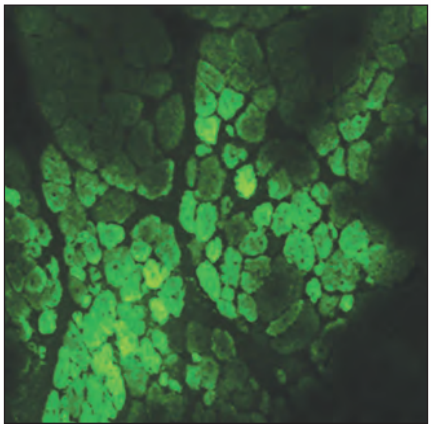


Figure 2: *Stable long term expression obtained after intramuscular injection of a PhiC31 plasmid encoding the green fluorescent protein (GFP) under the control of a muscle specific promoter followed by electroporation. Provided by Carmen Bertoni Ph.D Dept. of Neurobiology UCLA.*

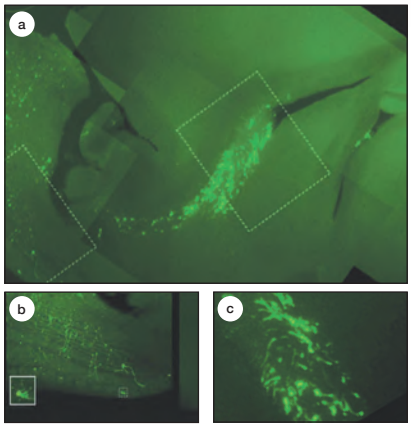


Figure 3: *A. Sagital views of a P15 mouse 2 weeks post electroporation; 60 µm sections. In addition to the RMS, GFP-positive cells can be found throughout the olfactory bulb. B/C. Enlarged views of the boxed regions in (a) showing olfactory bulb (b), and the RMS (c). Inset in (b) highlights a periglomerular cell. (Chesler et al. 2008).*

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 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

Study 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. Peng et al. (2012) used the ECM 2001+ generator and flat electrodes to introduce RNA to study the signaling pathways in the developing mouse embryo.

Zebrafish

Zebrafish have shown to be a very useful model for studying vertebrate development given the transparency of the larvae during early stages of development. Xu et al. (2010) utilized a zebrafish model and an ECM 830 system to characterize the signaling pathway involved in retinal axon guidance during development. This in vivo data corroborated previous in vitro results

Mouse Embryonic Brain

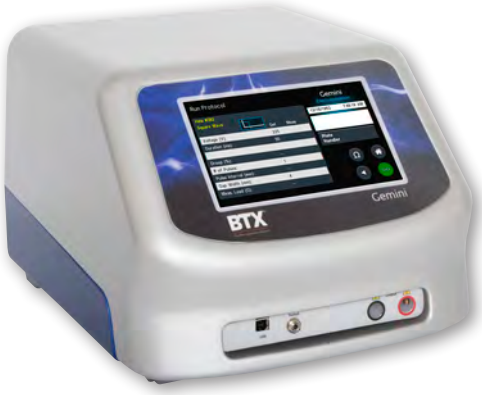
With the help of BTX electroporation generators (Tonelli et al. 2006) were able to transfect a dual-fluorescence reporter/sensor plasmid into the mouse embryonic brain. They developed a technique to detect expression at the single cell level making it possible to monitor miRNA appearance and disappearance 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 Usmani et al. (2013) were able to perform in vivo transfection to deliver genes directly in mouse testes without surgical preparation. The transfection, aided through the use of Tweezertrode electrodes, successfully established stably transfected spermatogonial cells. These mice were then mated to wild type females and sired transgenic offspring.

ECM™ 830
Square Wave
Electroporation
Generator

ECM™ 2001+
Square Wave
Electroporation
Generator



Gemini
Twin Wave
Electoporation
Generator

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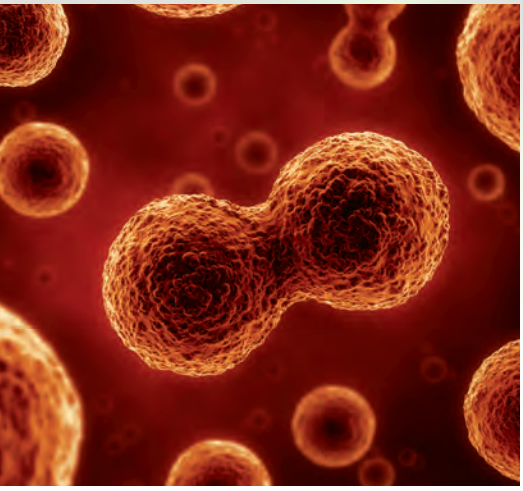
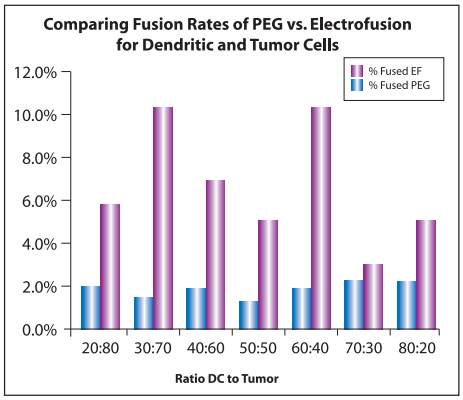
Mammalian, Oocyte & Plant Electrofusion



Electrofusion is a highly efficient, reproducible and non-toxic technique used in a wide variety of applications. The number of applications using electrofusion has greatly increased in the past decade and include hybridoma production for antibody expression, stem cell development, genetically modified plant protoplast, tetraploid fusion and nuclear transfer for transgenic development. Many applications have potential 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 coaxial chambers or microslide fusion chambers. These chambers help deliver a gentle, low intensity, high frequency AC pulse to align the cells while the DC square wave pulse fuses the cells for higher fusion rates compared to other chemical methods. The ECM 2001+ can function as a highly efficient AC/DC electrofusion system or to transfect a variety of mammalian cells, including direct gene delivery into oocytes or in vivo tissues by simply turning off the AC features and utilizing the DC square wave pulsing capabilities.

Typical Results



Fusion of dendritic cells to tumor cells was determined by loading either CMFDA or CMTMR fluorescent labels into cells. Fusion was carried out by using PEG-mediated fusion and Electrofusion methods. The cells were analysed by flow cytometry. Cells expressing both fluorescent labels were considered fused. Electrofusion resulted in significantly higher numbers of fused cells in comparison to PEG.

Rimas J.Orentas, Dennis Schauer, Qian Bin, and Bryon D. Johnson; Electrofusion of a weakly Immunogenic Neuroblastoma with Dendritic Cells Produces a Tumor Vaccine. Cell. Immunol 2001;213: 4-13.

Applications

- Hybridoma production
- Nuclear transfer
- Stem cell production
- Mammalian cell fusion
- Mammalian cell transfection
- Oocyte transfection
- In vivo applications

AC/DC

The adjustable 0.2-2.0 MHz AC frequency and advanced programming capability to combine multiple pre- and post- fusion AC steps enable the user to effectively align cells for cell fusion and maintain alignment during cell recovery. Voltage settings of 5 V up to 3000 V pulse lengths of 0.01 to 0.99 ms and multiple pulsing up to 99 pulses can be selected in the DC pulsing step for unmatched fusion capabilities.

Dual System

The ECM 2001+ is not only an efficient standalone 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 cytotoxic 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 unfertilized 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.

ECM™ 2001+

Square Wave Electrofusion and Electroporation Generator

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.

Glass Microslides

BTX Glass Microslides are used for cell fusion, somatic cell nuclear transfer, plant protoplast fusion, hybridoma development and embryo manipulation applications in small to medium scale. They readliy fit on a microscope stage for easy observation.

Coaxial Chambers

BTX Coaxial chambers are used for medium to large scale cell fusion, such as hybridoma development applications. The 2 ml optimization coaxial chamber fits on a microscope stage to view and optimize cell alignment settings. The 9 ml production coaxial chamber has the same electrical specifications as the 2 ml chamber for easy scale-up.

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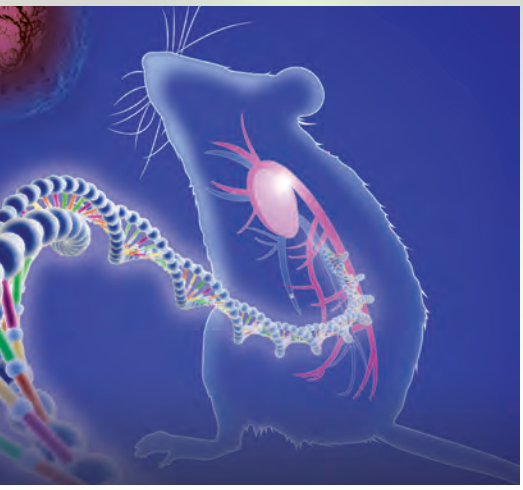
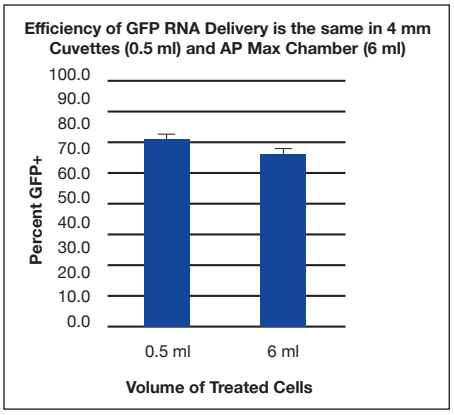
Large Volume Transfection



BTX offers advanced electroporation solutions for fast, efficient transfection of 20 µl to 10 ml of cell suspension in cuvettes, single use flat packs, or AgilePulse™ MAX large volume chambers. Specifically engineered for large-volume applications, the AgilePulse MAX system maximizes cellular uptake with minimal heating and short cycle-time to ensure high cell viability in further cell processing. Simple to use, cells and polynucleotide are suspended in our proprietary BTXpress Cytoporation™ medium and transferred via sterile syringe to either the large-volume electroporation chamber, flat pack or cuvette, where a programmed sequence of electric pulses is applied. First, a sequence of short, high-intensity pulses opens pores in the cell membranes, followed by long, low-intensity pulses that drive the material into cells via electrophoresis. Our patented Pulse Agile® technology optimizes these pulse parameters to maximize efficiency and cell viability.

Typical Results



Simple direct scale-up of transfection using the AgilePulse MAX System. K562 cells were transfected with GFP+ mRNA in standard 4 mm gap electroporation laboratory cuvettes (0.5 ml) and AgilePulse MAX chambers (6.0 ml). Identical pulse parameters were applied to all three elecroporation chambers. At 24 hours post electroporation, the percent transfection was determined by flow cytometry. The efficiency of transfection was comparable for both chambers.

(Markovic S, et al. Preparing clinical-grade myeloid dendritic cells by electroporation-mediated transfection of in vitro amplified tumor-derived mRNA and safety testing in stage IV malignant melanoma. J Translat Med. 2006 Aug;4: 35.)

AgilePulse™ MAX System

with Large Volume Flatpack Chamber, Safety Stand and Cuvette

Applications

- Transfection of cells such as bone marrow to produce or replace a missing protein
- Delivery of siRNA to suppress gene expression
- Delivery of genes for permanent gene correction
- Drug delivery
- Cancer immunotherapy
- Transfection of eukaryotic cells for protein production in bioreactors
- Large-scale production of replication-deficient viruses
- CRISPR gene editing

Scale Up

Transfection protocols readily scale up from standard laboratory cuvettes to large-volume transfection in the AgilePulse MAX system.

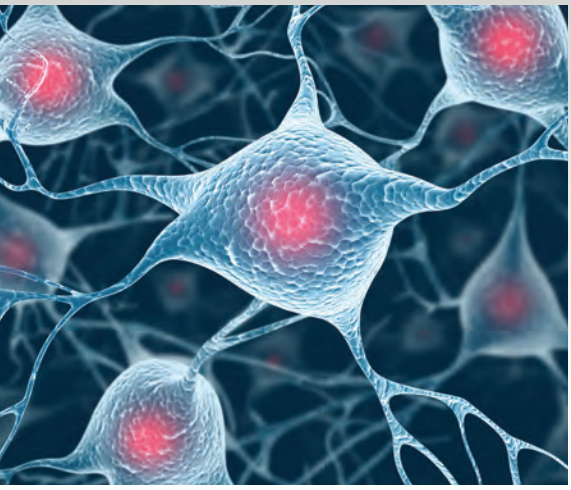
Maximal Efficiency with BTXpress Cytoporation Medium T

This medium has been optimized for maximal efficiency with a number of cell lines, including K562, A20, HEK293 and CHO-K1. It is compatible with a large range of transfectants including DNA, RNA, siRNA, and oligonucleotides. It can be directly diluted in complete growth medium for post-electroporation cell culture.

Pulse Agile® Advantage

Transfection efficiency and cell viability are enhanced by specialized, programmable electrical pulse waveforms, particularly important for larger polynucleotide delivery such as DNA plasmids. The patented Pulse Agile® technology combines a unique sequence of short high-intensity pulses to porate cell membranes, followed by long low-intensity pulses to further drive transfectants into cells via electrophoresis, while maintaining cell viability.

Vaccine Delivery



DNA vaccines represent a powerful and safe means of stimulating an immune response that recognizes and eliminates target molecules in the body. However, traditional DNA vaccine delivery systems, such as gene gun delivery, or injection alone suffer from poor efficiency. The AgilePulse In Vivo System provides an intra-dermal/intra-muscular/intra-tumor electroporation solution to produce maximum transfection efficiency.

For vaccine applications, DNA vaccination through the dermal layer is preferred since it is an easily accessible site that is immunologically active. After direct injection of plasmid DNA in the dermal layer, a programmed sequence of electric pulses is applied through a miniature parallel-needle electrode array to promote cellular uptake and transfection. Cells in the surrounding tissue are transfected, including dendritic antigen-presenting cells and mesenchymal origin cells. Gene expression stimulates the immune system to respond to the secreted antigen. Gene expression in skin is 100-fold higher when delivery is enhanced by electroporation compared to simply injecting plasmid DNA.

Applications

- Vaccine development
- Animal immunization
- Antibody production
- Intra-tumor gene delivery

Electroporation Increases the Immune Response

The AgilePulse In Vivo System is well-suited for applications requiring robust immune responses includes gene therapy and cancer vaccines. The system includes a user-friendly, programmable waveform generator with patented Pulse Agile® technology and a miniature parallel-needle electrode array, providing maximum efficiency DNA delivery.

Pulse Agile® Advantage

The patented Pulse Agile technology combines a unique sequence of short, high-intensity pulses to open pores in cell membranes, followed by long, low-intensity pulses to further drive the DNA into cells via electrophoresis. The adjustable pulses improve efficiency while maintaining cell viability. The specialized use of the Pulse Agile® waveform has shown to significantly enhance antigen-specific CD8+ T-cell response when standard protocols do not.

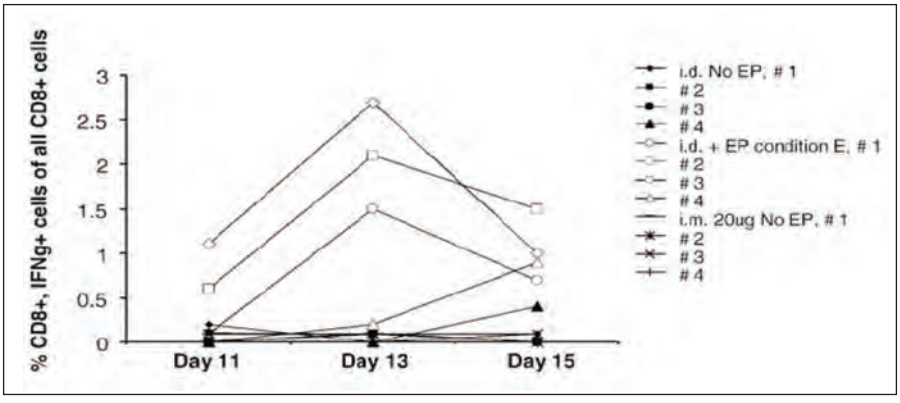
Uniform, Reliable Electroporation

AgilePulse parallel-needle arrays produce uniform electric fields across the treatment area for a more thorough transfection of the tissue. Electrode impedance is monitored through software analysis to ensure reliable electrode placement in tissue each and every time.

Simple, Fast Treatment

Simple yet effective intra-dermal or intra-muscular electrode design allows for shorter delivery times of less than a second. The electrodes provide a uniform pulse to cover and target larger areas of tissue using a single pulsing application. The miniature 4- or 6-needle arrays ranging from 2 mm to 16 mm in length easily penetrate the layers of skin or muscle and target cells for high efficiency gene delivery.

Typical Results



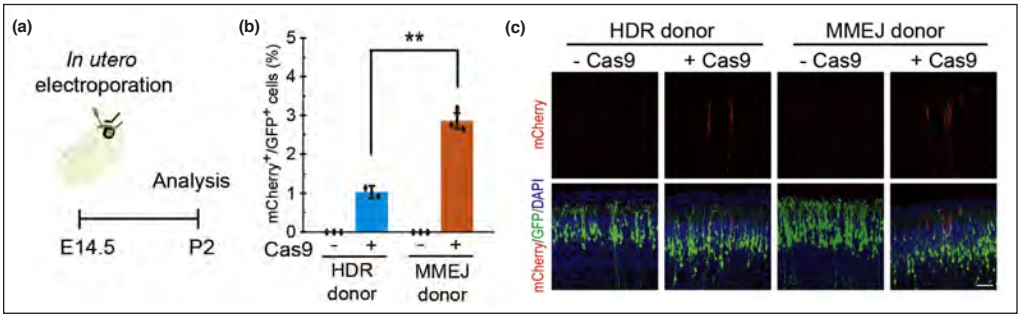
Dermal delivery of DNA vaccine with electroporation using the AgilePulse™ In Vivo System increases the immune response of PSA specific CD8+ T cells over intradermal (ID) alone or intramuscular injection (IM), with or without electroporation, (Roos, A, et al. Mol. Ther. 2006;13(2): 320-327.)

CRISPR Gene Editing

CRISPR, originally discovered as a bacterial 'immune' system against viruses, has elicited much excitement since it has been modified for use as a gene editing tool for eukaryotic cells. This powerful system works by creating a complex that includes a piece of guide RNA that targets a specific DNA sequence and recruits a protein (e.g. Cas9) which cuts the targeted sequence, and can result in gene inactivation via a point insertion or deletion. More complex sequence modifications are accomplished by addition of an optional section of DNA repair template that is utilized for knock-in or replacement at the target DNA cut site. This method allows researchers to alter genes with unmatched flexibility, precision and efficiency.

One of the key success factors in any gene expression and modification experiment (CRISPR, gene editing, engineering) is the optimal and efficient introduction of key components/molecules into your cell line in vitro or in vivo system. Due to its ease of use, reproducibility, high efficiency and low toxicity, BTX electroporation has become the method of choice for introducing CRISPR constructs into cells such as mammalian, bacterial, yeast, plant, parasite and insect.

Typical Results



Use of ECM 830 electroporation system and Tweezertrode electrodes for in vivo genome editing via microhomology-mediated end-joining (MMEJ)-mediated targeted integration. (a) Experimental scheme for targeted Actb-2A-mCherry knock-in in fetal brain via in utero electroporation. (b) Representative immunofluorescence images of neurons showing correct mCherry knock-in at the Actb locus. Scale bar, 50 µm. GFP, transfected cells. (c) Relative knock-in efficiency measured by the percentage of mCherry+ cells among GFP+ cells. Adapted from EBioMedicine, Xuan Yao, et al. (2017) with permission from Elsevier.

Transfect Everything with CRISPR using BTX Systems

Offering a flexible collection of square wave and exponential decay electroporators and specialty electrodes, BTX systems will support CRISPR-based transfection in virtually any cell type and preparation. Electroporation can be used as an effective transfection tool in vitro, including adherent, suspension, and primary cells, as well as for in vivo, in utero, in ovo and ex vivo applications.

A Solution for Hard-to Transfect Cells

Efficient transfection of the CRISPR construct into certain cells (e.g. stem cells, neurons, hematopoietic cells, zygotes, etc.) has been difficult—if not impossible—using standard transfection protocols. Electroporation allows for the efficient transfection of these difficult cell types by inducing transient pores to form in the cell membrane in response to a carefully controlled electrical pulse. The CRISPR construct moves into the cell through these pores and the cell membrane reseals after the pulse.

Transgenic Animals

CRISPR has had an immense impact on the development of transgenic animal models, opening the path for cost-effective, highly-efficient generation of transgenic offspring within weeks. BTX electroporation systems offer additional versatility and speed for CRISPR-mediated mutagenesis protocols in comparison to microinjection techniques. For high-throughput oocyte/zygote electroporation, BTX oocyte electrodes support transfection of up to 40 cells at a time while requiring little expertise. For embryonic electroporation, BTX Genepaddles™, Genetrodes™, and Tweezertrodes™ simplify localized transfection in utero and in ovo.

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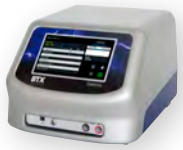
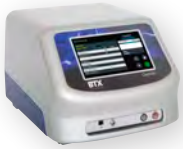
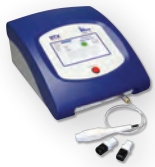
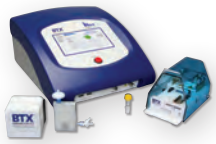
Systems & Guides

Our range of electroporation systems covers virtually every electroporation and electrofusion application, including high throughput. Please consult the Systems Selection Guide and the General Optimization Guide at the beginning of this section, and contact us for guidance on the most appropriate system for your work.

System Selection Guide

	 ECM™ 399	 ECM™ 630	 ECM™ 830	 Gemini™ X2
Feature	**Bacteria and Yeast Electroporation**	**Bacteria and Yeast Electroporation**	**Mammalian Cell Electroporation**	**All Cell Electroporation**
Square Waveform			●	●
Multi-Pulsing Square Wave			●	●
Exponential Decay Waveform	●	●		●
Multi-Pulsing Exponential Decay		●		●
Resistance/Pulse Monitoring		●	●	●
Experiment Log Storage		●	●	●
Preprogrammed Protocols		●	●	●
Unlimited Custom Protocol Storage		●	●	●
Remote Operation		●	●	●
PC Communications		●	●	●
Electroporation Applications				
In Vitro (Cuvette)	●	●	●	●
Eukaryotic Cells			●	●
Prokaryotic Cells	●	●		●
In Vivo (Specialty Electrodes)			●	●
Ex Plant / Tissue Slice (Petri Dish Electrodes)		●	●	●
In Ovo (Genetrodes)			●	●
Adherent Cell (Petri Pulser Electrodes)		●	●	●
96-Well (HT Plate Handler/96-Well Plates)		●	●	●
Large Volume (Max 10 ml Chambers)		●	●	●
Dermal Immunizations (Multi-Needle Array)				
Muscle Immunizations (Multi-Needle Arrays)				
Specifications				
User Interface	Digital User Interface	Touch Screen	Touch Screen	Touch Screen
Voltage Range	2 to 2500 V	5 to 3000 V	5 to 3000 V	5 to 3000 V
Pulse Width Range	Voltage Controlled	0.5 ms to 5 s	10 µs to 999 ms	10 µs to 5 s
Pulse Interval	N/A	5 to 30 s	100 ms to 10 s	100 ms to 30 s
Data Export	N/A	USB/PC Communication	USB/PC Communication	USB/PC Communication
Dimensions (L x W x H)	9.1 x 7.7 x 4.3 in	12.75 x 11.25 x 8.5 in	12.75 x 11.25 x 8.5 in	12.75 x 11.25 x 8.5 in
Weight	7 lb	16 lb	16 lb	16 lb
Operating Temperature	10° to 40° C	4° to 40° C	4° to 40° C	4° to 40° C
Mains Voltage	100 to 240 VAC	100 to 240 VAC	100 to 240 VAC	100 to 240 VAC

 Gemini SC	 ECM™ 2001+	 Hybrimune™	 AgilePulse™ In Vivo	 AgilePulse™ MAX
All Cell Electroporation	**Electroporation and Electrofusion**	**Hybridoma Creation**	**In Vivo Vaccine Electroporation**	**Large Volume Electroporation**
●	●	●	●	●
●	●	●	●	●
●				
●	●		●	●
	●	●	●	●
●	●			
●	●	●	●	●
	●	●		
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●	●			●
●	●	●	●	●
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	●		●	
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	●	●		●
			●	
			●	
Touch Screen	Touch Screen	PC Software Interface	Touch Screen	Touch Screen
10 to 3000 V	5 to 3000 V	100 to 1000 V	50 to 1000 V	50 to 1200 V
50 µs to 3 s	10 µs to 999 ms	20 µs to 1000 µs	50 µs to 10 ms	50 µs to 10 ms
100 ms to 30 s (SW only)	0.1 s to 10 s	125 ms to 10 s	200 µs to 1 s	200 µs to 1 s
N/A	USB/PC communication	PC Software Interface	USB Flash Key	USB Flash Key
12.75 x 11.25 x 8.5 in	13 x 12 x 13 in	12 x 16 x 6.5 in	6.5 x 12 x 16 in	12.6 x 7.9 x 15.7 in
16 lb	22 lb	15 lb	12 lb	25 lb
4° to 40° C	4° to 40° C	20° to 30° C	10° to 40° C	10° to 40° C
100 to 240 VAC	100 to 240 VAC	100 to 240 VAC	100 to 250 VAC	100 to 250 VAC

General Optimization Guide

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 proprietory 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 waveform, 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.

Waveforms

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

Square wave pulse: Pulses rise quickly to a set voltage level, maintains this level during the duration of the set pulse length and quickly turn off. This yields higher efficiencies and viabilities in mammalian cells. Square wave electroporation in in vivo and ex vivo tissues, embryos, 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. This powerful pulse is routinely used for transformation of gram-negative and gram-positive bacteria, 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. It 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: cuvette gap size, cell diameter, and temperature.

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 4 mm gap cuvette with 500 V would provide a field strength of 1.25 kV/cm. If instead of a 4 mm gap cuvette, a 2 mm gap cuvette was used, the voltage would have to be reduced by half or 250 V in order to maintain the same field strength of 1.25 kV/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 1 mm gap cuvette the calculation would be: 1.25 kV x 0.1 cm= 0.125 kV or 125 volts.

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

Cell Types	Field Strength Ranges
Bacteria/Yeast	3–24 kV/cm
Mammalian	0.25–3 kV/cm
Plant	3–12 kV/cm

2. Cell Diameter

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

Cell Diameter	Cuvette 4 mm, Room Temp.	Cuvette 4mm, 4°C
10 µm	500 Volts	1000 Volts
15 µm	350 Volts	700 Volts
20 µm	250 Volts	500 Volts
30 µm	180 Volts	360 Volts
40 µm	130 Volts	250 Volts
50 µm	100 Volts	200 Volts

3. Temperature

The temperature at which cells are maintained during electroporation effects the efficiency of electroporation. A majority of mammalian cell lines are effectively electroporated at room temperature. Samples 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 lower 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 to effectively permeate the cell membrane.

Pulse Length

The pulse length is the duration of time the sample is exposed to the pulse, measured as time in micro to millisecond 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 input directly. The pulse length in an exponential decay wave system is called the "time constant," characterized by the rate at which the pulsed 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. The time constant is calculated through the equation 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 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 voltage and needs to be considered when optimizing electrical 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 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 30–50 msec provides efficient transfection. The optimal voltage, pulse length and number of pulses will vary depending on the cell type and molecule (DNA or RNA) transfected.

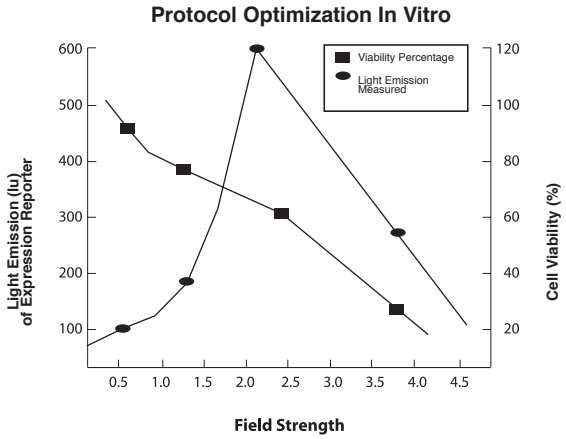
Electroporation Buffer

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 hypoosmolar buffers in which cells absorb water shortly before pulse. This cell swelling lowers 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 effect on the resistance of the sample. This 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.

BTXpress™ High Performance Electroporation Solution and Cytoporation Medium T are low conductance buffers that achieve higher transfection efficiencies with minimal cell toxicity. BTXpress buffer is recommended for small volume mammalian cell electroporation, and Cytoporation Medium T is intended for large volume mammalian cell applications.

Nucleic Acid Concentrations

Electroporation is typically thought of as a nucleic acid transfer method into prokaryotic and eukaryotic cells. It can also introduce proteins, antibodies, small molecules and fluorescent dyes. The standard range of DNA used for transfections is 5–20 µg/ml for most cell types; however in some instances increasing the DNA concentration as high as 50 µg/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 diH_2O, dialysis, or ethanol precipitation can significantly improve transformation efficiencies and reduce the potential for arcing.



Choose the optimal field strength based on the best conditions observed when plotting viability versus expression at different field strengths.

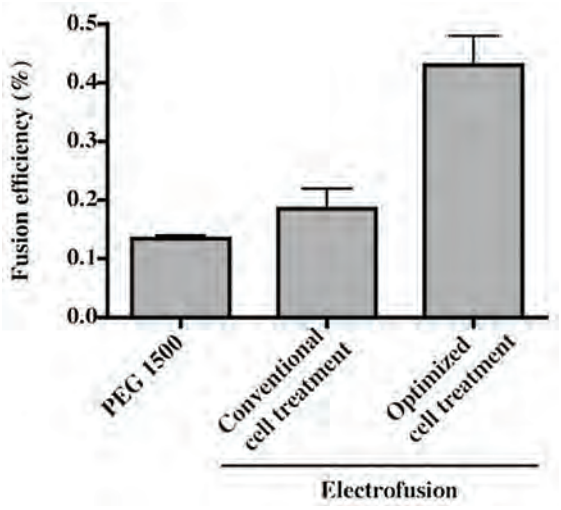
Guide to Electrofusion vs. PEG

Electrofusion and PEG-induced fusion are two methods used to fuse cells for applications such as nuclear transfer, hybridoma production and tumor vaccine production. Studies over many years demonstrated the benefits of electrofusion versus PEG. Use of electrofusion for such applications provides a reliable, reproducible and cost effective method compared to traditional polyethylene glycol-mediated fusion.[1,7,8]

Electrofusion joins the membranes of neighboring cells by the application of a pulsed electrical field. Electrofusion uses the properties of two waveforms; an oscillating AC waveform for cell alignment, and a DC square wave pulse for the fusion:

1. The AC waveform is applied to align cells by dielectrophoresis. More specifically, an electric field induces a dipole within cell. As cells move toward a common point the dipoles attract and pearl-chain formation results.
2. A DC waveform pulse is applied which fuses the cells together whereby a brief but intense electric field forms temporary pathways or pores in the cell membrane.
3. A post fusion AC waveform pulse is applied to hold fused cells together while the pathways between the cell membranes mature. The waveform holds cells in place with gentle force to promote fusion.

Optimized Electrofusion Settings are More Efficient than PEG Fusion



HHMA 2.5 cells were fused with EBV-transformed human B cells to test the effect of optimized cell treatment conditions before and after electrofusion. (Yu, et al. 2008)

Comparison of PEG and Electrofusion for Cell Fusion Applications

PEG	Electrofusion
Peroxide build up in PEG solutions contributes to cell cytoxicity.[2]	Considerably higher efficiencies for many cell types. Hybrid yields are up to 80-fold over PEG-mediated fusion.[5]
Aldehydes can build up in PEG due to autoclaving or non-optimal storage conditions.[2]	Better reproducibility.
PEG is less effective at promoting fusion when cells are in suspension versus cells that are attached to a substrate. [2]	Significantly lower amount of B cells required.
Lower fusion efficiencies.[3]	Fast and easy-to-use protocol; multiple fusions can be performed in a short period of time.
>10^6 cells are required for PEG-mediated fusion.[6]	Better growth properties in the early stage following fusion.[2]
PEG-induced fusion is unreliable since the success of a fusion depends on many variables such as the size and shape of the pellet and method by which PEG is stirred into the resuspended cell pellet.[3,4,5]	Optimized and reproducible protocols are available for specific cells.
Cell membranes undergoing fusion with PEG are uniformly affected, which may cause a greater loss of cellular constituents.	Direct control of fusion results.
	Controllable physical parameters that are independent of genetic, biochemical, physiological, or morphological cell properties.[5]
	Simple technique.
	Can be viewed in real time under a microscope.

References

1 http://www.umass.edu/vetimm/docs/Wagner_Hybridoma.pdf.
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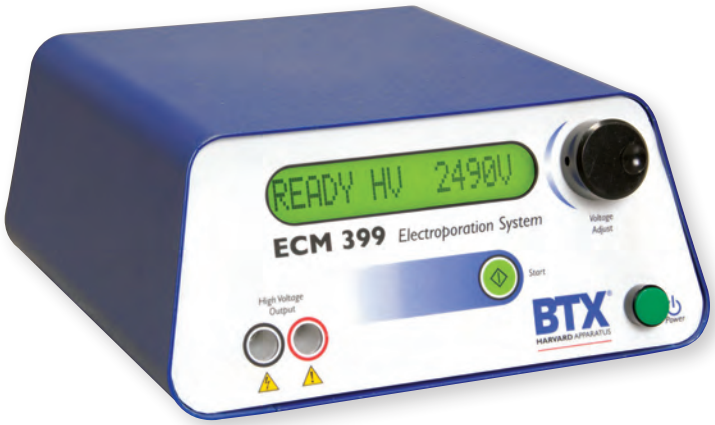
3 Orentas, R. et al.,Electrofusion of a Weakly Immunogenic Neuroblastoma with Dendritic Cells Producesa Tumor Vaccine, 2001, *Cellular Immunology* 213, 4–13.
4 Karsten, S. et al., Direct comparison of electric field-mediated and PEG-mediated cell fusion for the generation of antibody producing hybridomas, 1988, *Hybridoma 7*, 627-633.
5 Radomska, H. et al., Mammalian Cell Fusion in an Electroporation Device, 1995, J*ournal of Immunological Methods.*
6 Kreutz, F. T. et al., A New Method to Generate Quadromas by Electrofusion and FACS Sorting, Vol 17, No 3, 1998, *Hybridoma.*
7 Lentz, BR. Et al., Poly(ethylene glycol) (PEG)-mediated fusion between pure lipid bilayers: amechanism in common with viral fusion and secretory vesicle release? 1999, *Molecular Membrane Biology.*
8 Lentz, Br et al., Polymer-induced membrane fusion: potential mechanism and relation to cell fusion events, 1994, *Chem Phys Lipids.*
9 Yu, X. et al., An optimized electrofusion-based protocol for generating virus specific human monoclonal antibodies, 2008, *Journal of Immunological Methods.*

ECM™ 399 Exponential Decay Wave Electroporation System

Economical electroporation system for gram-negative bacteria and yeast applications



Personal Electroporation Pak

Safety Stand and Cuvette Rack

Applications

- Basic bacteria and yeast transformation
- Mammalian transfection (limited, in low voltage mode)

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.

Features

- Highest transformation efficiencies of basic bacteria and yeast strains
- Easy to operate
- Cost effective
- Compact in size and portable
- Available as complete system with cuvettes and cuvette rack

Specifications

Operational Status	Internal self test upon start-up
Interface	Digital User Interface
Input	110 to 240 VAC
Charge Time	5 s
Voltage Range	LV Mode: 2 to 500 V in 2 V steps HV Mode: 10 to 2,500 V in 10 V steps
Capacitance	LV Mode: 1,050 µF fixed; HV Mode: 36 µF fixed
Resistance	LV Mode: 150 Ω fixed; HV Mode: 150 Ω fixed
Maximum Pulse Length	125 ms at 500 V peak or 5 ms at 2,500 V peak
Safety	Generator short circuit proof

Ordering Information

Item #	Description	Included Items
45-0000	ECM 399 Electroporation System, Complete, for Cuvettes	ECM 399 Generator, PEP, Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each) and Cuvette Rack 660
45-0207	Safety Stand, Adjustable Gap	Safety Stand
45-0050	ECM 399 Generator Only	ECM 399 Generator only

ECM™ 630 Exponential Decay Wave Electroporation System

Electroporation system primarily used for bacteria and yeast transformation

Applications

- Transformation of bacteria and yeast
- Transfection of mammalian cells
- Transfection of plant cells and plant protoplasts
- High throughput option, 25- and 96-well

The ECM™ 630 is an exponential decay wave electroporation generator providing a broad range of voltage and time constants 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 for 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 the ECM630 to be a plug and play system that easily transitions between standard cuvettes and 96-well electroporation plates using our high throughput plate handler.

Monitoring Option

The addition of 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 waveform 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. For more information visit www.btxonline.com.

Features

- Wide and accurate exponential decay voltage and pulse length ranges
- Preset protocols—includes the most common bacteria and microorganism cell types
- User-defined protocols—unlimited ability to add and modify protocols
- Safety—displays resistance measurements for each pulse with three layers of arc protection
- Data management—stores logs of every pulse delivered for QC and troubleshooting
- Ease of use—touch screen operation

Specifications

Operational Status	Internal self test upon start-up
Interface	Touch screen interface
Input	100 to 240 VAC
Charge Time	LV <7 s, HV <4 s
Arc control	Yes
Voltage Range	LV Mode: 5 to 500 V in 1 V steps HV Mode: 505 to 3000 V in 5 V steps
Capacitance	LV Mode: 25 to 3275 µF in 25 µF steps HV Mode: 10, 25, 35, 50, 60, 75, 85 µF
Internal Resistance	LV 25 to 1575 Ω in 25 Ω steps HV 50 to1575 Ω in 25 Ω steps
Maximum Time Constant	5 s at 500 V peak or 133 ms at 3,000 V peak
Programmability	Storage over 1,000 Protocols
Safety	Pre-Pulse Sample Resistance Check, Pulse Over Current Protection

Ordering Information

Item #	Description	Included Items
45-2051	ECM 630 Electroporation System with Safety Dome,	ECM 630 Generator, Safety Dome, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each) and Cuvette Rack 660
45-0651	ECM 630 Electroporation System with Safety Stand,	ECM 630 Generator, 630B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each) and Cuvette Rack 660
45-0652	ECM 630 Generator only	ECM 630 Generator only
45-0655	ECM 630 System with Monitoring	ECM 630 Generator, 630 B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm pkg of 30 (10 each), Cuvette rack 660, Enhancer 3000 probe, Enhancer interface box, Oscillioscope and cables

ECM™ 630 High Throughput System

Multi-well electroporation with the addition of a plate handler

Applications

- Bacteria, yeast and insect cell transformations
- cDNA and siRNA library screening
- High throughput 25- and 96-well

The High Throughput 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 25-well or 96-well electroporation by using one simple plate handler. This increases yields and the number of experimental 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 High Throughput System is comprised of three components: Muli-Well Plates, an HT Plate Handler and the ECM 630 Generator.

Multi-Well Electroporation

Transition from standard cuvette work using the safety and to multi-well electroporation is quick and simple with the addition of a high throughput (HT) plate handler and multi-well plates. High throughput electroporation permits large numbers of samples to be quickly processed. Electroporation conditions are more easily optimized, providing the highest possible efficiency.

High Throughput Plate Handlers

The key to the high throughput system is the addition of a plate handler and multi-well electroporation plates. The HT-100 Plate Handler has pulse switching technology integrated into the package and gold-plated contacts to mate with a 96-well electroporation plate. The Plate Handler delivers a single pulse to the wells of the plate, column by column, using parameters set in the ECM 630 generator. The HT-100 plate handler works with 96-well plates and come with an adapter to accommodate 25-well plates with our ECM 630 generator.

Ordering Information

Item #	Description	Included Items
45-0653	ECM 630 High Throughput System, 25-well with HT-100	ECM 630 Generator, 25-Well Plates (2 mm gap, 6X), Plate Seals, HT-100 Plate Handler and a plate adaptor
45-0654	ECM 630 High Throughput System, 96-well with HT-100	ECM 630 Generator, 96-Well Plates (2 mm gap, 2X), Plate Seals, HT-100 Plate Handler and a plate adaptor
45-0656	ECM 630 High Throughput System with Monitoring	ECM 630 Generator, 630B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each), Cuvette Rack 660, Enhancer 3000 Probe, Enhancer Interface Box, Oscilloscope, Cables, 25-Well Plates (2 mm gap, 6X), HT-200 Plate Handler and a plate adaptor

ECM™ 830 Square Wave Electroporation System

Versatile electroporation system for gene, drug and protein delivery

Applications

- CRISPR transfections
- Mammalian cell transfection
- In vitro, in vivo, ex vivo and in ovo tissue transfection
- Nuclear transfer
- Ex plant tissue transfection
- Protoplast transfection
- siRNA libraries

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. Applications of the versatile ECM 830 for gene, drug and protein delivery include mammalian cells, in vivo and ex vivo tissues, zebrafish tissue and embryos, nuclear transfer, embryo manipulation, plant protoplast and basic bacteria and yeast transformations. The ECM 830 is a true laboratory workhorse with a 2-year warranty.

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. For more information visit www.btxonline.com.

Features

- Wide and accurate square wave voltages from 5 to 3,000 volts, with fine voltage discrimination
- Pulse durations from 10 µsec to 999 milliseconds
- Multiple pulsing capability and control of pulse intervals
- Preset protocols for commonly used mammalian cell lines and tissues
- User-defined protocols—unlimited ability to add and modify
- Safety—displays resistance measurements for each pulse with three layers of arc protection
- Data management—stores logs of every pulse delivered for QC and troubleshooting
- Ease of use—touch screen operation
- 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

Specifications

Operational Status	Internal self test upon start-up
Interface	Touch screen Interface
Input	100 to 240 VAC
Charge Time	LV <7 s, HV <4 s
Arc Control	Yes
Voltage Range	LV Mode: 5 to 500 V in 1 V steps HV Mode: 505 to 3,000 V in 5 V steps

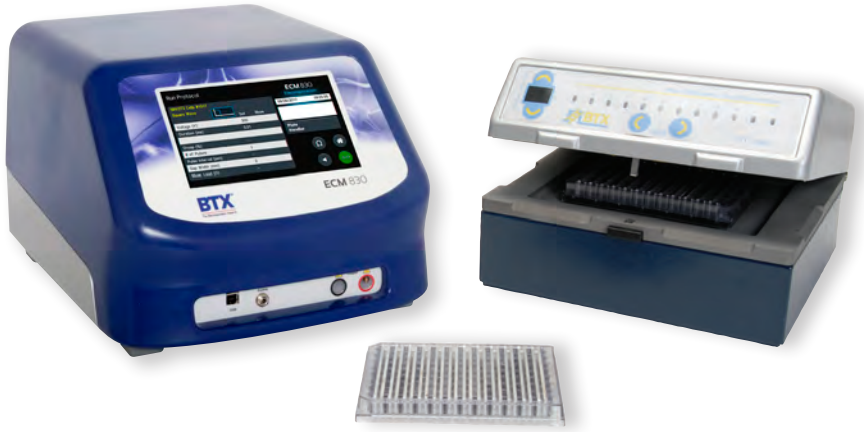
Pulse Length Range	LV Mode: 10 to 999 µs in 1 µs steps LV Mode: 1 to 999 ms in 1 ms steps HV Mode: 10 to 600 µs in 1 µs steps
Multiple Pulsing	1 to 99 (per individual sample) or 1 to 120 (10 per sample, with HT plate handler)
Pulse Interval	100 ms to 10 s
Programmability	Storage over 1,000 Protocols
Safety	Pre-Pulse Sample Resistance Check , Pulse Over Current Protection

Ordering Information

Item #	Description	Included Items
45-2052	ECM 830 Electroporation System with Safety Dome	ECM 830 Generator, Safety Dome, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each) and Cuvette Rack 660
45-0661	ECM 830 Electroporation System with Safety Stand	ECM 830 Generator, 630B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each) and Cuvette Rack 660
45-0662	ECM 830 Generator Only	ECM 830 Generator only
45-0667	ECM 830 System with Monitoring	ECM 830 Generator, 630 B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each), Cuvette Rack 660, Enhancer 3000 Probe, Enhancer Interface Box, Oscilliscope and Cables

ECM™ 830 High Throughput System

Multi-well electroporation with the ECM 830 with the addition of a plate handler



Applications

- Mammalian cell transfection, including primary and stem cells
- cDNA and siRNA library screening
- High throughput 25- and 96-well

The High Throughput 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 25-well or 96-well electroporation plate by using one simple plate handler. This increases yields and the number of experiments run 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 High Throughput System is comprised of three components: HT Multi-Well Plates, an HT Plate Handler and the ECM™ 830 Generator.

Multi-Well Electroporation

Transition from standard cuvette work using the safety stand to multi-well electroporation is quick and simple with the addition of a high throughput (HT) plate handler and multi-well plates. High throughput electroporation permits large numbers of samples to be quickly processed. Electroporation conditions are more easily optimized, providing the highest possible efficiency.

High Throughput Plate Handlers

The key to the high throughput system is the addition of a plate handler and multi-well electroporation plates. The HT-100 and HT-200 Plate Handlers have pulse switching technology integrated into the package and gold-plated contacts to mate with a 25- or 96-well electroporation plate. The plate handler delivers a single pulse to the wells of the plate, column by column, using parameters set in the ECM 830 generator. The HT-100 uses manual track switching, while the HT-200 employs auto-sense track switching. Both plate handlers work with 96-well plates and come with an adapter to accommodate 25-well plates with our ECM 830 generator.

Ordering Information

Item #	Description	Included Items
45-0663	ECM 830 High Throughput System, 25-well with HT-100	ECM 830 Generator, 25-Well Plates (2 mm gap, 6X), Plate Seals, HT-100 Plate Handler and a plate adaptor
45-0664	ECM 830 High Throughput System, 25-well with HT-200	ECM 830 Generator, 25-Well Plates (2 mm gap, 6X), Plate Seals, HT-200 Plate Handler and a plate adaptor
45-0665	ECM 830 High Throughput System, 96-well with HT-100	ECM 830 Generator, 96-Well Plates (2 mm gap, 2X), Plate Seals, HT-100 Plate Handler and a plate adaptor
45-0666	ECM 830 High Throughput System, 96-well with HT-200	ECM 830 Generator, 96-Well Plates (2 mm gap, 2X), Plate Seals, HT-200 Plate Handler and a plate adaptor
45-0668	ECM 830 High Throughput System with Monitoring	ECM 830 Generator, 630B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each), Cuvette Rack 660, Enhancer 3000 Probe, Enhancer Interface Box, Oscilloscope, Cables, 25-Well Plates (2 mm gap, 6X), HT-200 Plate Handler and a plate adaptor

Gemini Twin Wave Electroporation System

Square wave and exponential decay wave electroporation in a single unit

Applications

- CRISPR transfections
- Suspension cells
- Adherent cells
- In vivo gene and drug delivery
- In ovo gene and drug delivery
- In utero gene and drug delivery
- Tissue explants
- Transformation of eukaryotic and prokaryotic cells
- High throughput transfection of eukaryotic and prokaryotic cells

The Gemini Twin Wave Electroporators are flexible systems allowing both square wave and exponential decay wave electroporation in a single unit. These waveform combinations enable researchers to easily and efficiently electroporate eukaryotic and prokaryotic cells in cuvettes or plates with one easy-to-use setup. Ideal for all of your electroporation needs, including CRISPR, in vivo, in vitro, in ovo and more.

Features

- Square wave and exponential decay wave electroporation in a single unit
- Wider and more accurate voltage and pulse length ranges
- Multiple pulsing capabilities in both square and exponential decay waveforms (X2 systems)
- Universal electroporation—transfects all cell types including difficult to transfect cells
- Special applications—transfects cells in vitro, in vivo, in ovo and adherent forms
- Preset protocols—includes the most common eukaryotic and prokaryotic cell types
- User-defined protocols—unlimited ability to add and modify protocols
- Safety—displays resistance measurements for each pulse with three layers of arc protection
- Data management—stores logs of every pulse delivered for QC and troubleshooting

Gemini SC

The Gemini SC system is designed specifically for transfecting eukaryotic or prokaryotic cells in suspension. In one simple setup, square wave and exponential decay waves can be applied to cells in cuvettes. With a wide range of pulsing parameters, advanced safety features as well as dozens of pre-set protocols, the Gemini SC can be used in any lab requiring efficient cell transfection or transformation without the use of costly reagents.

Gemini X2 and Gemini X2 HT

The Gemini X2 Systems is designed for researchers who need the ultimate experiment flexibility. In one easy setup, square wave and exponential decay waves can be applied to cells in any format. These systems incorporate remote operation functionality via footswitch or PC and internal log storage of experiment data for easy optimization, quality control requirements and troubleshooting.

Electroporation of suspension cells can be achieved in cuvettes (X2) or 96-well plates (X2 HT) with an HT plate handler. Additionally, the Gemini X2 can be paired with BTX specialty electrodes to deliver gene and drugs in vivo, in utero, in ovo and to explant tissues as well as adherent cells.

Features & Benefits

Exponential Decay/Square Twin Waveforms

Allows researchers to select which type of waveform they would like to use to transfect eukaryotic cells or transform prokaryotic cells. Typically, eukaryotic cells respond best to square wave pulses while prokaryotic cell respond well to exponential decay wave pulses. Combining these two waveforms gives researchers total flexibility to achieve the highest efficiency for their application.

Simple User Interface

The simple user interface permits intuitive touch screen or computer-controlled protocol programming and execution as well as password protection of protocols. Each system is programmable and offers unlimited protocol storage as well as dozens of proven pre-set protocols to reduce optimization time. The X2 systems provide protocol delivery log storage. Logs can be accessed for quality control, optimization or troubleshooting purposes.

Pre-Pulse Resistance Measurement

The pre-pulse resistance measurement offers assurance that sample resistance is within acceptable range for electroporation. This feature protects precious sample as well as system component to safeguard against arcing.

Widest Voltage/Pulse Length Range Available

The Gemini provides researchers with the widest range of voltage options available on the market.

- The Gemini X2 can achieve voltage delivery as low as 5 V and as high as 3000 V in both waveforms in addition to pulse lengths of 10 µs to 5 s, for electroporation of delicate in ovo tissue to hearty gram-positive bacteria.
- The Gemini SC can achieve voltage delivery as low as 10 V and as high as 3000 V in both waveforms in addition to pulse lengths of 50 µs to 3 s.

Highly Accurate Pulsing

Gemini delivers precise voltage, pulse length/time constant, pulse interval and displays the values back to the researcher allowing for visual confirmation of successful electroporation.

Revolutionary Arc Proofing Safety Features

Gives researchers peace of mind knowing that their sample and their systems are safe from troublesome arcing with enhanced 4-way safety checks through the pulsing procedure. Using two separate pre-pulse, sample resistance monitoring scans to ensure proper conditions, and internal safety features auditing pulse progress at the component as well as software level, arcing is dramatically decreased.

Specifications

Operational Status	Internal self test upon start-up
Interface	Touch screen interface
Input	100 to 240 VAC
Charge Time	LV <7 s, HV <4 s
Arc Control	Yes
Voltage Range	LV Mode: 5 to 500 V / 1 V resolution; HV Mode: 505 to 3000 V / 5 V resolution
Capacitance (Exponential Decay Wave)	LV Mode: 25 to 3275 µF / 25 µF resolution HV Mode: 10, 25, 35, 50, 60, 75, 85 µF
Internal Resistance (Exponential Decay Wave)	LV Mode: 25 to 1575 Ω in 25 Ω steps HV Mode: 50 to 1575 Ω in 25 Ω steps

Maximum Time Constant (Exponential Decay Wave)	5 s at 500 V peak 133 ms at 3,000 V peak
Pulse Length Range (Square Wave)	10 µs to 999 µs LV Mode/ 1 µs resolution 1 msec to 999 ms LV Mode/ 1 ms resolution 10 µs to 600 µs HV Mode/ 1 µs resolution
Programmability	Storage over 1000 protocols
Multiple Pulsing (Square Wave)	1 to 99 (per individual sample) or 1 to 120 (10 per sample, with HT plate handler)
Safety	Pre-Pulse Sample Resistance Check Pulse Over Current Protection

Ordering Information

Item #	Description	Included Items
45-2040	Gemini X2 Electroporation System with Safety Dome	Gemini X2 Generator, Safety Dome, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each), and Cuvette Rack 660
45-2041	Gemini X2 Electroporation Generator Only	Gemini X2 Electroporation Generator Only
45-2042	Gemini SC Electroporation System with Safety Dome	Gemini SC Generator, Safety Dome, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each), and Cuvette Rack 660
45-2043	Gemini SC Electroporation Generator Only	Gemini SC Electroporation Generator Only.
45-2044	Gemini X2 High Throughput System, 96-well with HT-200	Gemini X2 Generator, Safety Dome, Cuvettes 1 mm, 2 mm, 4 mm pkg. of 30 (10 each), and Cuvette Rack 660, HT-200 Plate Handler, 2 mm gap HT plate and 4 mm gap HT plate

ECM™ 2001+ Electro Cell Fusion & Electroporation System

Multi-purpose electro cell manipulation generator

Applications

- Cell fusion
- Hybridoma production
- Nuclear transfer
- Embryo manipulation
- Mammalian cell transfection
- Plant protoplast fusion
- Stem cell production

The ECM 2001+ is a multifunctional electrofusion and square wave electroporation generator. The ability to generate both AC and DC waves allows for fast and efficient cell fusion in hybridoma production, hybrid cell formation, and nuclear transfer applications. This system is powerful enough to yield high transfection efficiencies for cell lines and difficult to transfect cell types including stem cells and primary cells. The gentle square wave pulse also allows for high cell viability of these cell types.

Features

- AC waveform of 0.2 – 2.0 MHz
- Square wave electroporation capabilities
- A wide range of voltages from 5 V to 3000 V
- Advanced programming capability to combine multiple AC steps pre- and post- DC fusion step
- Capable of operating at low impedance loads
- Large touchscreen interface

Waveforms

AC sine wave aligns cells by dielectrophoresis for electrofusion applications. Square DC waveform provides the fusion pulse for electrofusion or is utilized in mammalian electroporation applications.

Electrofusion

Fast, efficient cell fusion in hybridoma production, hybrid cell formation and nuclear transfer applications are facilitated by the combination of AC and DC wave pulses. Fusion is achieved by the generation of an AC current wave form that generates a benign dielectrophoretic alignment of cells. With a 30 ms switchover time from AC to DC, efficient fusion takes place. After fusion, the AC is reapplied maintaining the cell compression for the rounding off process resulting in a higher number of hybrids.

Hybridoma Production

For use in large-scale hybridoma production applications, the ECM 2001+ generator, 2 ml coaxial optimization or 9 ml coaxial production chambers, high voltage output cable, and female-female adapters may be used. Alternatively, for medium-scale hybridoma production applications, the ECM 2001+ generator may be combined with 650 ml, 3.2 mm gap or 2 ml, 10 mm gap microslides, high voltage output cable, and micrograbber adapters. This system does not require proprietary fusion medium, however may be used with the Cytofusion Medium C for enhanced efficiency, reproducibility, and convenience.

Electroporation

Electroporation is a standard method used to transfect mammalian cell lines to express recombinant human proteins which are used for therapeutic purposes. Gene delivery by this method is typically used in transient transfections to study protein expression or to temporarily knockout or “silence” these genes using siRNA. This is used to study gene targeting and function. Alternatively, adding additional selection steps to isolate stably transfected cells allows for integration of a gene into the genome of the cell for long term expression of protein. The use of the ECM 2001++ offers the control needed to adjust electrical settings for optimization of parameters.

Adherent Cell Transfection

Electroporate adherent cells directly into the dish used for cell growth. The ECM 2001++ coupled with the Petri Pulser electrode or the Petri Dish electrode allows researchers to avoid the trypsinization of their cells by electroporating adherent cells directly in the dish in which they are growing. The Petri Pulser is ideal for 6-well plates and the Petri Dish Electrode is ideal for 100 mm Petri dishes

Specifications

SQUARE WAVE PULSE, DC	
Voltage Range	LV Mode 5 to 500 in 1 V steps HV Mode 505 to 3000 in 1 V steps
Voltage Accuracy	5%
Pulse Length	LV Mode 10 to 999 µs in 1 µs steps or 1 to 999 ms in 1 ms steps HV Mode 1 to 999 µs in 1 µs steps
Multiple Pulsing	1 to 99 pulses per sample
Pulse Interval	0.1 s to 10 s
AC STEPS (UP TO 19 PRE- AND POST- FUSION)	
Frequency	0.2 to 2 MHz in 0.1 MHz steps
Voltage	5 to 75 V in 5 V steps
Duration	0 to 99 s 1 s steps
Wave Shape	Sine Wave
SAMPLE LOAD RANGES	
All Voltages	Load must be ≥ 60 Ω
LV Mode	Pulse Length < 100 ms, Load must be > 8 – 9 Ω; Pulse Length > 100 ms, Load must be >100 Ω
HV Mode	Load must be ≥ 40 Ω

Ordering Info

Item #	Description	Included Items
45-2045	ECM 2001+ Cell Fusion System	ECM 2001+ Generator, Microslides (0.5 mm Gap, 3.2 mm Gap), Meander Fusion Chamber, Flat Electrode / Divergent Field, Electrode Adapter, Connection Cable, Safety Stand 630B, Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each) and Cuvette Rack
45-2046	ECM 2001+ Electroporation System,	ECM 2001+ Generator, 630B Safety Stand, Cuvettes 1 mm, 2 mm, 4 mm, pkg. of 30 (10 each) and Cuvette Rack
45-2047	ECM 2001+ Embryo Manipulation System	ECM 2001+ Generator, Microslides, round wire (0.5 mm gap, 1.0 mm gap), rectangular wire (3.2 mm gap), Micrograbber adapter cables
45-2048	ECM 2001+ Hybridoma Production System	ECM 2001+ Generator, 2 ml Optimization Coaxial Chamber, 9 mL Production Coaxial Chamber, High Voltage output cable, Female/Female Adapter set, BTX Cytofusion Medium C 500 ml
45-2049	ECM 2001+ Generator Only	

Hybrimune™ Hybridoma Production System

Fast, efficient cell fusion in a programmable waveform generator

Applications

- Hybridoma production
- Hybrid cell formation
- Dendritic-tumor cell fusions

The Hybrimune™ Hybridoma Production System is an advanced electrofusion system for fast, efficient cell fusion in hybridoma production, hybrid cell formation, and dendritic-tumor cell fusions.

The Hybrimune system consists of a user-friendly, programmable waveform generator controlled through the User-Interface Application Software running on a Windows®-based computer system (purchased separately). Included with the Hybrimune is a set of innovative fusion chambers using coaxial electrodes designed for optimal electric field stimulation, independent of bath height to facilitate optimization and direct scale-up. BTXpress Cytofusion medium used with the Hybrimune system is a specially formulated, low conductivity solution for robust cell fusion efficiency.

Features

- Hybrimune advantage—hybridoma production efficiency and cell viability are enhanced by specialized waveforms. The patented Ramp-K™ feature enhances cell compression, resulting in high fusion rates and excellent cell viability.
- Non-uniform waveform—provides rapid cell alignment and compression for increased fusion.
- Scale-up—direct scale-up from 2 ml to 9 ml to large-volume hybridoma production in the Hybrimune system.
- Programmable—Easy programmable user-friendly Windows® based software. Data logs are stored and retrieved easily.

How It Works

Cells are combined in the proprietary BTXpress Cytofusion Medium C and transferred to the coaxial fusion chamber under sterile conditions. A tri-phasic sequence of programmed pulses is applied. First, an AC waveform positions the cells into “pearl-chain” alignment using dielectrophoretic force. A gradual increase in AC amplitude compresses the cells for maximal cell-cell contact. Then, a short, robust DC pulse porates the cell membranes to permit cell content exchange and cell fusion. The researcher has the option of doing multiple pulses of different voltages and duration if required. A final AC waveform holds the cells in place and stabilizes the fusion as the force is gradually reduced. The waveform generator is fully programmable for pulse parameter optimization to maximize efficiency and cell viability.

Hybrid Yield Improvements of Tenfold or More Compared to Standard PEG Fusion

The Hybrimune System is designed for fast, efficient hybridoma production as a first step in monoclonal antibody production. Electrofusion combines cell positioning and electroporation into a single, robust process for maximum efficiency. The innovative fusion chamber design permits direct scale-up of pulse parameters to production volumes. A 10-fold greater efficiency over standard polyethylene glycol (PEG) fusion has been demonstrated for Hybrimune electrofusion.

Antigen Specific Clones		
Experiment Number	**Electrofusion**	**PEG**
1	20	0
2	10	0
3	400	24
4	141	21
Mean	**145**	**11**

Four different transgenic mice expressing Abs to human Ag were used to compare the efficiency of electrofusion to PEG fusion. *Transgenic, human-Ab producing mice immunized with tetanus toxoid (TT) provided spleens for fusion to SP2/O mouse myeloma cells. PEG fusion was performed with standard protocols. For electrofusion, mouse and SP2/O cells were washed twice in Cytofusion medium then mixed in the fusion chamber and tri-phasic pulse applied. Cells were recovered after 30 min and cultured in 96-well plates at 5000 cells/ml. Antigen-specific clones were counted using ELISA or HTRF, normalized to 100M cells. Source: Data courtesy of M. Coccia, PhD, Platform Development Group, Medarex Inc, Milpitas, CA)*

Specifications

Pulse Voltage Ramping	Constant, linear, non-linear
Pulse Amplitude	100 to 1000 V
Pulse Width Range	20 to 1000 ms
AC Start Peak Range	5 to 75 V

AC Stop Peak Range	5 to 75 V
AC Frequency	0.2 to 2.0 MHz
AC Duration	0 to 60 s

Ordering Information

Item #	Description	Included Items
47-0300N	Hybrimune Electrofusion System	Hybrimune Generator, 2 ml and 9 ml Coaxial Chambers, BTXpress Cytofusion Medium C, User Interface Software, and Cables. (Requires Windows based laptop or PC - not included).
47-0305N	Hybrimune Electrofusion, Generator Only	Hybrimune Electrofusion, Generator Only

Coaxial Chambers for Optimization and Production

Coaxial fusion chambers are used with the Hybrimune Hybridoma Production System. Both the 2 ml optimization and 9 ml production chambers have been engineered to have identical electrical characteristics to facilitate direct scale-up to production, once pulse parameters have been optimized. In addition, the 2 ml chamber has a transparent bottom to permit visualization of the cell alignment by inverted or regular microscope. These chambers must not be used with voltages greater than 1,000 V.

For reuse, the fusion chamber can be cleaned with NaOH, followed by sterilization with alcohol and Spor-Klenz® and mycoplasma.

Hybrimune User Interface Application Software

The Hybrimune system requires that interface software (47-0301) be installed on a local computer that is connected to the unit by either a RS232 Serial Port or a USB port. This software is used to program and control the Hybrimune generator. Purchased separately.

Ordering Information

Item #	Description
45-0497	2 ml Coaxial Chamber for optimization
47-0020	9 ml Coaxial Chamber for production
Required for connection to Hybrimune	
47-0302	Hybrimune Chamber Cable
Required for connection to ECM 2001+	
45-0088	Female/Female Adapter Set for Banana Plug Cables

Specifications

Parameters	Optimization Chamber	Production Chamber
Volume	2 ml	9 ml
Outer ID	45.72 mm	45.72 mm
Inner OD	38.10 mm	38.10 mm
Gap	3.81 mm	3.81 mm
Well Height	5 mm	18 mm
Inner/Outer Radius	0.8333	0.8333

AgilePulse™ In Vivo Waveform Electroporation System (ID and IM)

Maximum efficiency DNA vaccination delivery

Applications

- Vaccine development
- Intra-dermal gene delivery
- Intra-muscular gene delivery
- Intra-tumor gene delivery

The AgilePulse™ In Vivo System, used for vaccine development and gene therapy, provides an intra-muscular or intra-dermal electroporation solution to produce maximum transfection efficiency.

Traditional DNA vaccine delivery systems, such as gene gun delivery, suffer from poor efficiency. The AgilePulse In Vivo System effectively introduces DNA vaccines, representing a powerful and safe means for stimulating an immune response that recognizes and eliminates target molecules in the body.

For vaccine applications, DNA vaccination through the dermal layer is preferred since it is an easily accessible site that is immunologically active. After direct injection of plasmid DNA in the dermal layer, a programmed sequence of electric pulses is applied through a miniature parallel needle electrode array to promote cellular uptake and transfection. Cells in the surrounding tissue are transfected, including dendritic antigen-presenting cells and mesenchymal origin cells. Gene expression simulates the immune system to respond to the secreted antigen. Gene expression in skin is 100-fold higher when delivery is enhanced by electroporation compared to simply injecting plasmid DNA (Roos, et. al. 2009).

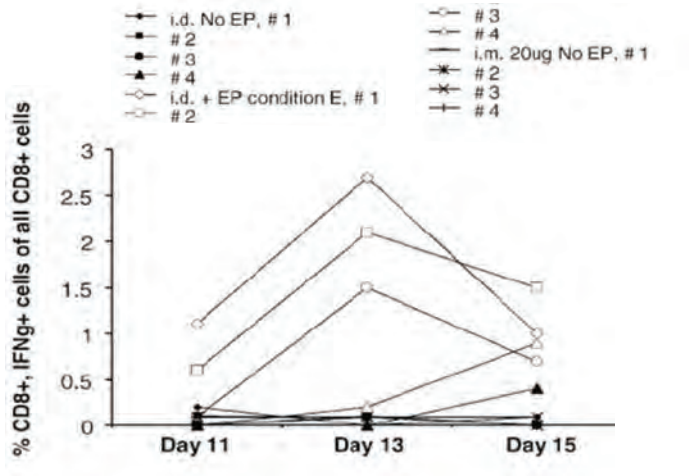
Features

- Simple User Interface—touch screen user interface, USB key data storage, and Windows® Mobile 6.0 operating system. The system automatically stores a digitized record of all pulse parameters for quality control. EN 60601-1, EN 60601-1-1 EN 60601-1-2, UL60601-1 and CSA601.1 compliant.
- Pulse Agile® Advantage—patented Pulse Agile technology combines a unique sequence of short, high-intensity pulses to open pores in cell membranes, followed by long, low-intensity pulses to further drive the DNA into cells via electrophoresis. The adjustable pulses improve efficiency while maintaining cell viability. The specialized use of the Pulse Agile waveform has shown to significantly enhance antigen specific CD8+ T-cell response when standard protocols do not.
- Uniform, Reliable Electroporation—AgilePulse parallel-needle arrays produce uniform electric fields across the treatment area for a more thorough transfection of the tissue. Electrode impedance is monitored through software analysis to ensure reliable electrode placement in tissue each and every time.
- Simple, Fast Treatment—simple yet effective intra-dermal or intramuscular electrode design allows for shorter delivery times of less than a second. The electrodes provide a uniform pulse to cover and target larger areas of tissue using a single pulsing application.
- Optimal Design—miniature, 2 mm length needles easily penetrate the layers of skin or muscle and target cells for high efficiency gene delivery.
- Safety—Each needle electrode array comes with a safety cover and easy grip sides to make the electrode insertion procedure simple and safe.

Specifications

User Interface	Touch screen display, Footswitch
Voltage Range	50 to 1,000 V
Pulse Width Range	0.050 to 10 ms
Pulse Interval	0.200 to 1,000 ms (5 kHz to 1 Hz)
Data Export	USB Flash Drive
Dimensions (W x H x L) (with handle)	32 cm x 20 cm x 40 cm (12.6 in x 7.9 in x 15.7 in)
Weight	25 lb (11.3 kg)
Operating Temperature	10 to 40°C
Mains Voltage	100 to 250 VAC
Fuse	5 Amp Slo-Blo, 5 mm x 20 mm
Software	IM (Intra-muscular) or ID (Intra-dermal)

Typical Results



Electroporation increases the immune response. C57Bl/6 mice were immunized once with 10 pVax-PSA/20 ml PBS intradermally (id) on each flank with or without electroporation (EP) or intramuscular (IM) in each TA muscle. Blood was collected on days 11, 13 and 15 and effector cells were stimulated for 4 h with 100 nM PSA-derived peptide psa65-73 or a control peptide GP33. The activated CD8+ T cells were quantified by intracellular cytokine staining for IFN-γ and analyzed by flow cytometry. The data demonstrate that dermal delivery of DNA vaccine along with electroporation using the AgilePulse In Vivo System increases the immune response of PSA-specific CD8+ T cells over intradermal (ID) alone or intramuscular injection (IM), with or without electroporation. Roos, A, et al. *Molec. Ther.* 2006;13(2): 320-327.

Ordering Information

Item #	Description	Included Items
47-0400N	AgilePulse In Vivo ID (Intra-Dermal) System	AgilePulse ID Generator, Handle for Parallel Needle Array (47-0000), 4-needle Parallel Needle Array, 6-needle Parallel Needle Array and ID Software
47-0401N	AgilePulse In Vivo ID (Intra-Dermal). Generator Only	AgilePulse In Vivo ID (Intra-Dermal) Generator Only
47-0500N	AgilePulse In Vivo IM (Intra-Muscular) System	AgilePulse IM Generator, Handle for Parallel Needle Array 47-0000), 4-needle Parallel Needle Array, 6-needle Parallel Needle Array and IM Software
47-0501N	AgilePulse In Vivo IM (Intra-Muscular), Generator Only	AgilePulse In Vivo IM (Intra-Muscular) Generator Only
47-0090	AgilePulse Adaptor Box	AgilePulse Adaptor Box, to accept electrodes with 4mm diameter banana plug attachments

AgilePulse™ MAX Waveform Electroporation System

Large volume transfection system

Applications

- Transfect cells such as bone marrow to produce or replace a missing protein
- Deliver siRNA to suppress gene expression
- Deliver genes for permanent gene correction
- Load cells with a drug for drug delivery
- Cancer immunotherapy
- Transfect eukaryotic cells for protein production in bioreactors
- Large-scale production of replication-deficient viruses
- CRISPR transfections

The AgilePulse™ MAX System is an advanced electroporation solution for fast, efficient transfection of up to 10 ml of cell suspension. Specifically engineered for large-volume applications, our system maximizes cellular uptake with minimal heating and short cycle-time to ensure high cell viability in further cell processing.

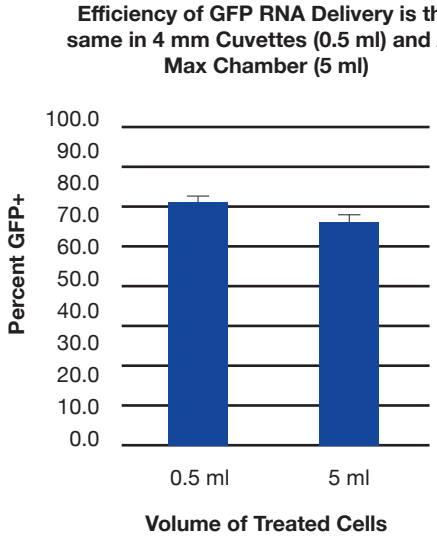
The AgilePulse MAX System is simple to use. Cells and polynucleotide are suspended in our proprietary BTXpress Cytoporation Medium T or Cytoporation Medium T4 and transferred via sterile syringe to the large volume electroporation chamber where a programmed sequence of electric pulses is applied. First, a sequence of short, high-intensity pulses opens pores in the cell membranes. These are followed by long, low-intensity pulses that drive the material into cells via electrophoresis. Our patented Pulse Agile technology optimizes these pulse parameters to maximize efficiency and cell viability.

The system includes a user-friendly, programmable waveform generator with patented Pulse Agile technology, our patent-pending large-volume electroporation chamber, and proprietary BTXpress Cytoporation Medium, optimized for large volume electroporation. The system is engineered to provide uniform electric fields in a stable temperature environment for excellent cell viability.

Features

- Scale-up—transfection protocols readily scale-up from standard laboratory cuvettes to large-volume transfection in the AgilePulse MAX system.
- Maximal Efficiency with Cytoporation Medium—BTXpress Medium T used with the AgilePulse MAX system has been optimized for maximal efficiency with a number of cell lines, including K562, A20, HEK293 and CHO-KI. It is compatible with a large range of transfectants including DNA, RNA, siRNA, and oligonucleotides. It can be directly diluted in complete growth medium for post-electroporation cell culture.
- Simple User Interface—all controls are operated with the simple touch screen on the front panel. Data is quickly retrieved by USB key and can be analyzed for detailed pulse characteristics including pulse and pulse current.
- Pulse Agile® Advantage—transfection efficiency and cell viability are enhanced by specialized, programmable electrical pulse waveforms, particularly important for larger polynucleotide delivery such as DNA plasmids. The patented Pulse Agile technology combines a unique sequence of short high-intensity pulses to porate cell membranes, followed by long low-intensity pulses to further drive transfectants into cells via electrophoresis, while maintaining cell viability.

Typical Results



Scale-up of K562 cell mRNA transfection using AgilePulse MAX system. *K562 cells (myelomonocytic cells commonly used for natural killer target cell assays) were transfected with GFP+ mRNA in both laboratory cuvettes (0.5 mL) and the large volume AgilePulse MAX System. Cells were suspended to a cell density of 20 million cells/mL in Cytoporation Medium. GFP mRNA was added to the cell suspension to a final concentration of 40 µg/mL. The small 0.5 mL volume transfections were carried out using standard 4 mm gap electroporation cuvettes. The large volume transfections were performed with the AgilePulse MAX using a 4 mm gap large volume chamber. Identical pulse parameters were applied to all three volumes. At 24 hours post-electroporation, the percent transfection was determined by flow cytometry. The efficiency of transfection was comparable for all volumes. (Markovic S, et al. Preparing clinical-grade myeloid dendritic cells by electroporation-mediated transfection of in vitro amplified tumor-derived mRNA and safety testing in stage IV malignant melanoma. J Translat Med. 2006 Aug;4: 35.)*

Specifications

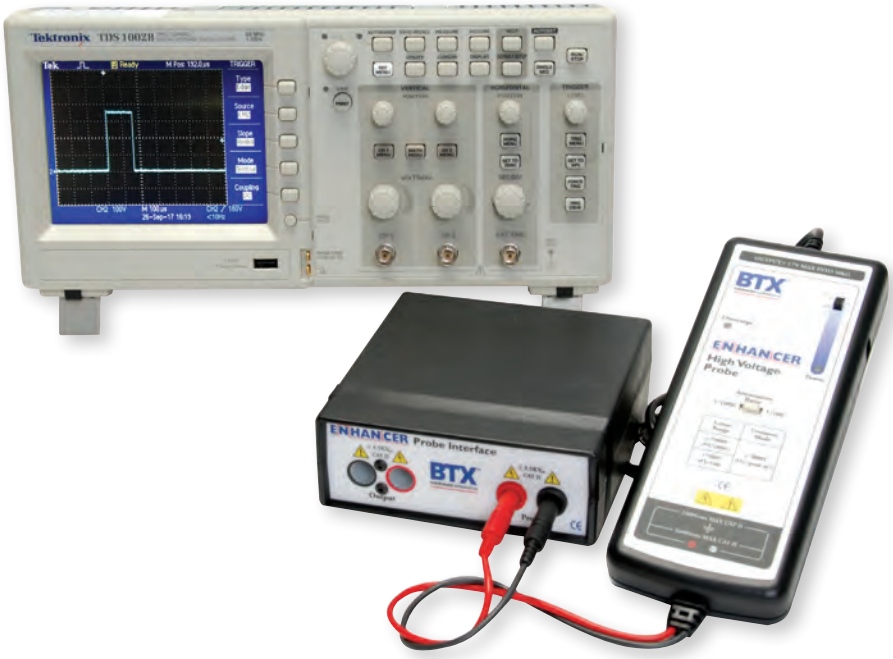
User Interface	Touch screen display, Footswitch
Voltage Range	50 to 1,200 V
Pulse Width Range	0.050 to 10 ms
Pulse Interval	0.200 to 1,000 ms (5 kHz to 1 Hz)
Data Export	USB Flash Drive
Dimensions (W x H x D) (with handle)	32 cm x 20 cm x 40 cm (12.6 in x 7.9 in x 15.7 in)
Weight	25 lb (11.3 kg)
Operating Temperature	10 to 40°C
Mains Voltage	100 to 250 VAC
Fuse	5 Amp Slo-Blo, 5 mm x 20 mm
Software	IM (Intra-muscular) or ID (Intra-dermal)
User Interface	Touch Screen Display

Ordering Information

Item #	Description	Included Items
47-0200N	AgilePulse MAX Large Volume Transfection System	AgilePulse MAX Generator, Large Volume Chamber Stand, Safety Stand, 6 ml Chamber (2X), Cytoporation Medium T, 500 ml, and 4 mm gap Cuvettes
47-0201N	AgilePulse MAX, Generator Only	AgilePulse MAX, Generator Only

Enhancer 3000 Monitoring Systems

Monitor critical parameters while performing electroporation applications



Applications

- Optimize and troubleshoot electroporation settings
- Capture and print results for documentation purposes
- Track and download images to computer for analysis
- Compatible with ECM 630, ECM 830, and ECM 2001+

The Enhancer 3000 Monitoring 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 simply interfaces between the generator and the electroporation chamber (safety stand or BTX electroporation plate handler). In addition, the optional communications module allows the user to send the waveform information directly to a printer or a computer.

Features

- Confirms and tracks all key electroporation parameters including waveform, pulse lengths, peak amplitude, pulse intervals, field strength, AC duration
- Monitors all waveforms for optimization or troubleshooting of electroporation parameters
- Facilitates calculation of field strength, pulse length, pulse duration or frequency
- Safe connections protect user from exposure to high voltage
- Optional Communications Module offers standard printer and computer interface

Ordering Information

Item #	Description	Included Items
45-0057	Enhancer 3000	Interface Box and Cables
45-0059	Enhancer 3000SC	Interface Box, Oscilloscope, Communications Module and Cables
45-0071	ECM 630 Enhancer System	ECM 630 Exponential Decay Wave Electroporation System (45-0001) and Enhancer 3000 (45-0059), Enhancer 3000 Probe, Enhancer Interface Box, Oscilloscope, Communications Module
45-0072	ECM 830 Enhancer System	ECM 830 Square Wave Electroporation System (45-0002) and Enhancer 3000 (45-0059), Enhancer 3000 Probe, Enhancer Interface Box, Oscilloscope, Communications Module
45-0013	ECM 2001+ Enhancer System	ECM 2001+ Electroporation System (45-0011) and Enhancer 3000 (45-0059), Enhancer 3000 Probe, Enhancer Interface Box, Oscilloscope with USB Communications
45-0471	HT 630 Enhancer System	ECM 630 Generator (45-0051), 2 mm HT Plates, HT-200 Plate Handler (45-0401) and Enhancer 3000 (45-0059)
45-0472	HT 830 Enhancer System	ECM 830 Generator (45-0052), 4 mm HT Plates, HT- 200 Plate Handler (45-0401) and Enhancer 3000 (45-0059)
45-0062	Enhancer 3000 High Voltage Interface Box	Includes Voltage Box Only
45-0063	Enhancer 3000 High Voltage Probe	Include Probe Only
45-0064	Enhancer 3000 Oscilloscope, Tektronix TDS1002B w/o 1X/10X Low Voltage Probes, 2-Channel, 60 mHz	Includes Oscilloscope and Probes

Note: *Communications module option is required to support printing and computer connection. Digital storage oscilloscope is required to display waveforms.*

MicroJect 1000A Max System

Deliver genes, proteins, macromolecules and microbeads by direct injection

Applications

- Nuclear transfer applications
- Transgenic animal development
- Injection into mouse, xenopus, zebrafish and oocytes
- Intra-cytoplasmic sperm injection
- Extracellular brain injections
- Injection of DNA, mRNA, microbeads and proteins

The MicroJect 1000A delivers targets by direct injection into cells and tissues. It provides consistent, precise delivery of volumes through digitally-controlled, stable pressure regulation maintained for a set time duration. The compressed gas, internally-controlled pressure system delivers desired volumes from femtoliters to microliters.

The Microject 1000A can hold a cell, oocyte or early stage embryo stationary while simultaneously using a separate pressure channel for injections. Get consistent performance injecting large volumes into tissue, or pico volumes for nuclear injections. It is also ideal for the gentle transfer of delicate fetal or stem cells into oocytes.

Pressure Control Features

- Key pressure features maximize injection potential with two negative and three positive pneumatic capabilities.
  - Negative pressure feature allows one to fill micropipettes from their tips.
  - "Fill" feature reduces waste.
  - "Hold" feature lets you immobilize and manipulate a cell or oocyte using a micropipette.
  - Positive pressure feature precisely discharges fluid by using the system's "Clear" function
- Unique "Balance" feature provides a secondary balance pressure to maintain positive pressure on the injection pipette, avoiding the chance of diluting sample due to capillary action.
- Two footswitches included for easy operation of the Clear/Fill features.

Specifications

Input Gas Pressure	70 to 105 psi (480 to 720 kPa)
Injection Pressure	0.2 to 60 psi (413 kPa), regulated, multi-turn control
Balance Pressure	0.1 to 3.5 psi (68.9 kPa), regulated, multi-turn control, other ranges available upon request
Fill Vacuum	Internally produced, -12.0 psi (-82 kPa), unregulated
Holding Vacuum	Internally produced, 0 to 3 in H_2O (0 to 0.75 kPa or 0 to 0.1 psi), regulated
Clearing Pressure	Input gas pressure, unregulated
Injection Timer	0.01 to 0.99 s in 10 ms steps; 1 to 99 s in Pulse Width 1 s steps
Injection Count Display	Digital, 0 through 9999
Duration Mode	Internally timed or externally gated
Time Trigger	Front panel, foot switch, or external TTL pulse (BNC)
Pressure Units	psi/kPa; switch selectable
Pressure Monitor	BNC connector, 10 mV/psi
Pressure Readout	Inject, balance, clear, output port
Line Voltage	100/110/220/240 VAC
Power Usage	220 W
Meter Accuracy	0.1% full scale
Foot Switches	Inject, fill, hold, and gated; provided in Plus and Deluxe packages
Weight	6.8 kg (15 lb)
Dimensions H x W x D	11 x 38 x 25.5 cm (5 x 15 x 10 in)
Accessories Supplied	Input, output and holding hoses

Ordering Information

Item #	Description	Included Items
45-0752	MicroJect 1000A Max System	MicroJect 1000A pico-injector with Injection, Balance, Clear/Fill and Hold pressures. Also included are two Footswitches, Input/Output Hoses, Holding Hose, two Pipette Holders and Input Adaptor for Hoses, Power Cord and Manual
45-0751	MicroJect 1000A Plus System	MicroJect 1000A pico-injector with Injection, Balance, Clear/Fill and Hold Pressure. Includes one Footswitch, Input/Output Hoses, Holding Hose, one Pipette Holder and Input Adaptor for Hoses, Power Cord and Manual
45-0750	MicroJect 1000A Basic System	MicroJect 1000A pico-injector with Injection, Balance, Clear/Fill and Hold Pressure, Power Cord and Manual

*Please visit btxonline.com for full list of accessories and ordering information

Electrodes & Chambers

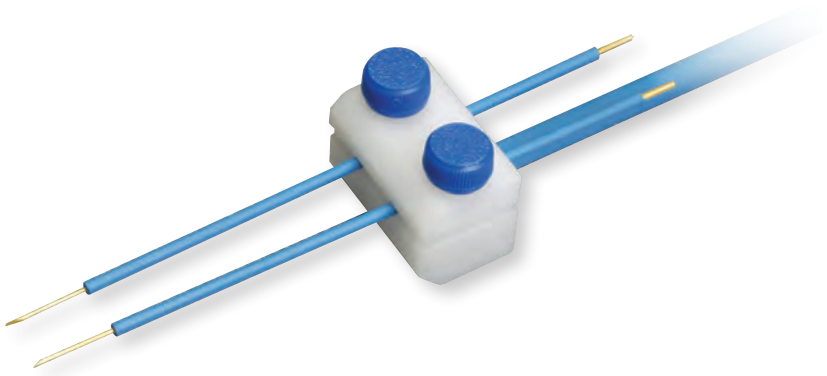
BTX offers a broad range of electrodes and chambers, specialized for tissue, cell type and application. Please consult our Electrodes Selection Guide at the beginning of this section for assistance in choosing the optimum electrodes and chambers for your needs.

Electrode Selection Guide

Application	Cell/Tissue	Instrument	Electrode Type	Field of Study	Comments
Ex Vivo	Brain tissue Brain slice	Gemini X2 ECM 830 ECM 2001+	Tissue Slice Chamber Tissue Chamber L-Shaped Needle	Neurobiology	Transfection of delicate brain tissue and tissues with unique morphologies are more easily transfected with the BTX tissue slice chamber, L-Shaped platinum needles or other BTX electrodes.
	Retina Cornea	Gemini X2 ECM 830 ECM 2001+	Tissue Slice Chamber Tissue Chamber Genepaddles	Developmental Biology Neurobiology	
	Tumor Skin	Gemini X2 ECM 830 ECM 2001+	Tissue Chamber Tweezertrodes Genetrodes	Cell Biology Ophthalmology Cancer Research Gene Therapy	
	Oocytes	Gemini X2 ECM 830 ECM 2001+	Oocyte Electrodes	Transgenic animals	Transfection of oocytes to generate animal models.
In Utero	Embryos	Gemini X2 ECM 830 ECM 2001+	Tweezertrodes Genepaddles Triple Electrode Tweezertrodes	Developmental Biology Neurobiology Neurology Embryology	The smaller size platinum Tweezertrodes (1 mm, 3 mm, and 5 mm) are ideal for use with early stage embryos.
In Vivo	Muscle	Gemini X2 ECM 830 ECM 2001+ Agile Pulse in Vivo	2-Needle Array Genetrodes Tweezertrodes Needle Array Electrodes	Gene Therapy	The numerous electrodes offered by BTX can be used for multiple tissue types depending on your specific application. For more assistance, please contact BTX Technical Support.
	Brain	Gemini X2 ECM 830 ECM 2001+	L-Shaped Needle Tweezertrodes Genepaddles	Neurobiology	
	Skin	Gemini X2 ECM 830 ECM 2001+ Agile Pulse in Vivo	2-Needle Array Genetrodes Tweezertrodes Needle Array Electrodes	Vaccine Development	
	Retina	Gemini X2 ECM 830 ECM 2001+	Tweezertrodes Genepaddles	Ophthalmology	
	Cornea	Gemini X2 ECM 830 ECM 2001+	Tweezertrodes Genepaddles	Ophthalmology	
	Tumors	Gemini X2 ECM 830 ECM 2001+	2-Needle Array Caliper Electrode Genetrodes Tweezertrodes	Cancer Research	
	Other Soft Tissue	Gemini X2 ECM 830 ECM 2001+	2-Needle Array Caliper Electrode Genetrodes Tweezertrodes Genepaddles L-Shaped Needle	Cell Biology Neurobiology Biological Sciences	
In Ovo	Chick Embryo	Gemini X2 ECM 830 ECM 2001+	L-shaped Genetrodes L-Shaped Needle	Developmental Biology Embryology	Genetrodes are available in four different sizes. L-shaped needle electrodes provide a finer diameter needle in various length tips to best suit the dimensions of your target tissue.
	Zebrafish	Gemini X2 ECM 830 ECM 2001+	L-shaped Genetrodes Tissue Chamber Genepaddles Tweezertrodes	Developmental Biology	
	Xenopus	Gemini X2 ECM 830 ECM 2001+	L-shaped Genetrodes Genepaddles Tweezertrodes	Regenerative Medicine Embryology	
	Mouse Oocyte/ Zygote	Gemini X2 ECM 830 ECM 2001+	Oocyte Electrode	Regenerative Medicine Embryology	
Plant	Plant tissue	Gemini X2 ECM 830 ECM 2001+	Tissue Chambers, Microslides Tweezertrodes, Cuvettes	Cellular Physiology	Various electrodes can be used for plant applications and depend on the target tissue.
	Seeds	Gemini X2	Tissue Chambers, Microslides Tweezertrodes, Cuvettes	Food and Agriculture	
	Anthers	Gemini X2 ECM 830 ECM 2001+	Tissue Chambers, Microslides Tweezertrodes, Cuvettes	Plant Biology	
	Pollen	Gemini X2	Tissue Chambers, Microslides Tweezertrodes, Cuvettes	Plant Embryology	
Adherent In Vitro	Mammalian Cells in Plates	Gemini X2 ECM 830 ECM 2001+	Petri Dish Petri Pulser Adherent Electrode	Cell Biology Cancer Neurobiology	Electrodes for transfecting while adherent are a good choice for cells sensitive to tranfection or polarized cells.

Genetrodes® Electrodes

Needle-style reusable electrodes for in vivo, ex vivo and in ovo gene delivery



Applications

- In vivo gene delivery
- Ex vivo gene delivery
- In ovo gene delivery

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 two styles—straight needle type gold tip electrodes with beveled ends or bent L-shaped electrodes with blunt ends. Each style comes as a pair of electrodes.

The electrodes are either inserted into a tissue or placed parallel to the target tissues following injection of the molecule of interest. An electroporation pulse is delivered using a BTX Electroporation System, such as the ECM 830, ECM 2001+ or Gemini X2. The electric field introduced by the Genetrode electrode causes transient pores to form in the cells of the tissue, allowing uptake of the molecules into the cells.

Specifications

Generator Compatibility	ECM 830, ECM 2001+, Gemini X2
Voltage Range	0 to 200 VDC
Pulse Length Range	10 µs to 99 ms
Diameter	Electrode tip 0.5 mm
Genetrode Holder	
Electrode Gap	1 to 10 mm range
Life Span	Approximately 1500 pulses

Genetrodes may be cleaned with a mild detergent and sterilized with ethanol or ethylene oxide. Properly maintained Genetrodes have a life span of approximately 1500+ pulses, and are compatible with most BTX electroporation systems.

Ordering Information

Order #	Description
45-0113	Genetrodes, 5 mm Straight (GOLD TIP)
45-0114	Genetrodes, 10 mm Straight (GOLD TIP)
45-0115	Genetrodes, 5 mm L-Shape (GOLD TIP)
45-0116	Genetrodes, 3 mm L-Shape (GOLD TIP)
45-0117	Genetrodes, 1 mm L-Shape (GOLD TIP)
45-0160	Genetrodes Kit, 5 mm Straight (GOLD TIP), with 45-0203 holder and 45-0216 cables
45-0161	Genetrodes Kit, 10 mm Straight (GOLD TIP) with 45-0203 holder and 45-0216 cables
45-0162	Genetrodes Kit, 5 mm L-Shape (GOLD TIP) with 45-203 holder and 45-0216 cables
45-0163	Genetrodes, 3 mm L-Shape (GOLD TIP) with 45-0203 holder and 45-0216 cables
45-0164	Genetrodes, 1 mm L-Shape (GOLD TIP) with 45-0203 holder and 45-0216 cables
45-0203	Genetrode/Genepaddle Holder
Required for connection to ECM 830 and Gemini X2	
45-0216	Micrograbber to Banana Plug Connection Cables, 10 ft
Required for connection to ECM 2001+	
45-0216	Micrograbber to Banana Plug Connection Cables, 10 ft
45-0088	Female/Female Adapter Set for Banana Plug Cables

2-Needle Array Electrodes

In vivo style electrode specifically designed for skin or muscle gene delivery

Applications

- In vivo drug or gene delivery
- Intra-muscular gene therapy
- Intra-dermal gene therapy

Among the non-viral techniques for gene transfer in vivo, the direct injection of plasmid DNA into muscle is simple, inexpensive, and safe. In vivo gene delivery by injection and electroporation of DNA into muscle tissue has been shown to enhance gene expression by 100-fold compared to injection alone. DNA vaccination by direct in vivo administration of plasmid-based DNA vectors has proven to be very effective in animal models. It has been demonstrated in the literature that non-viral electroporation enhances gene expression in muscle greatly, making it possible to induce immune response in large animals.

The 2-Needle Array Electrode is an in vivo style electrode specifically designed for intra-muscle or intra-dermal drug or gene delivery. It is available with 5 mm and 10 mm electrode gaps (distance between electrodes). The 45-0167 handle is designed for the 45-0120 10 mm needle tips and used for larger muscle masses, such as rat gastrocnemius. The 45-0168 handle is designed for the 45-0121 5 mm needle tips and is recommended for smaller muscle masses, such as mouse tibialis. Other species and tissues may be electroporated with the 2-Needle Array.

The kit consists of a reusable Delrin 2-needle array handle and disposable two-needle array assemblies. The needle array assemblies are conveniently packaged in “six packs.” The needles themselves are made of medical grade stainless steel.

To use, grasp the needle array handle and position over a needle array assembly. Push to secure the needle array onto the handle. Attach the handle to a BTX pulse generator via the high voltage banana cables. Remove the needle safety shield, place into the tissue, and deliver the pulse. Discard the needle array and prepare for the next experiment.

Specifications

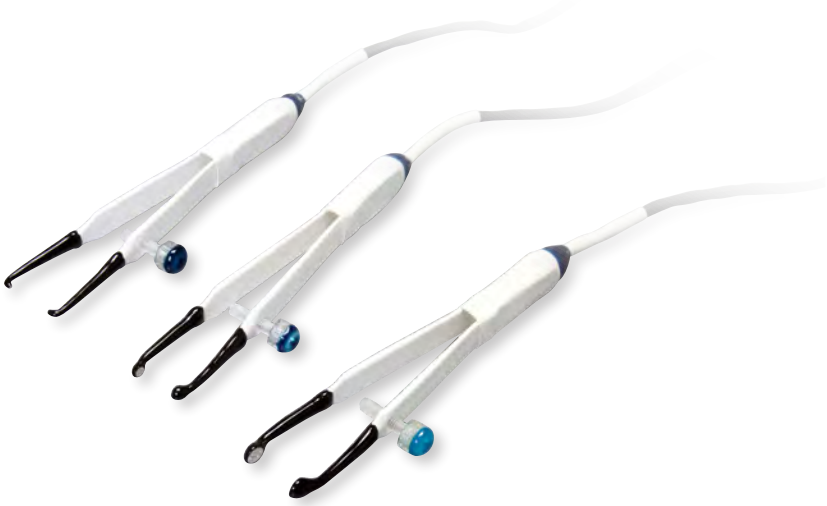
Generator Compatibility	ECM 830, ECM 2001+, Gemini X2
Voltage Range	0 to 500 VDC
Pulse Length Range	1 µs to 99 ms in PBS
Needles	20 mm length, stainless steel

Ordering Information

Order #	Description
45-0168	2-Needle Array Kit, 5 mm gap, Pkg. of 6, with 8 cm Delrin Handle
45-0167	2-Needle Array Kit, 10 mm gap, Pkg. of 6, with 8 cm Delrin Handle
45-0121	2-Needle Array, 5 mm gap, Pkg. of 6
45-0120	2-Needle Array, 10 mm gap, Pkg. of 6
45-0206	2-Needle Array Handle, for 45-0121 (5 mm)
45-0205	2-Needle Array Handle, for 45-0120 (10 mm)
Required for connection to ECM 830 and Gemini X2	
45-0088	Female/Female Adapter Set for Banana Plug Cables
45-0217	Banana to Banana Cables, Red and Black, 10 ft
Required for connection to ECM 2001+	
45-0088	Female/Female Adapter Set for Banana Plug Cables

Tweezertrodes™ Electrodes

Tweezer-style reusable electrodes for in vivo and in utero applications



Applications

- In vivo drug or gene delivery
- Ex vivo drug or gene delivery
- In utero drug or gene delivery

Tweezertrodes electrodes are reusable non-invasive, tweezer-style electrodes for drug or gene delivery in animal tissues. Tweezertrodes may be used for many in vivo applications, including in utero and ex-vivo gene transfection, electroporation therapy, and transdermal drug delivery.

Tweezertrodes consist of a standard 11.5 cm tweezer that has been modified with stainless steel circular or disk electrodes at the tip. The gap between the electrodes disks may be adjusted from under 1 mm to over 2 cm. Tweezertrodes are available in various sizes and two different metal alloys either platinum or stainless steel. Platinum Tweezertrodes are available in 1 mm, 3 mm, 4 mm and 7 mm diameters and stainless steel are available as either 7 mm or 10 mm diameters.

Triple Tweezertrodes have three electrode contacts with adjustable position and polarities. This type of triple electrode been shown to improve the efficiency of electrical field distribution for in utero electroporation applications (Dal Maschio, M. et al. “High-performance and site-directed in utero electroporation by a triple-eletrode probe.” *Nature Communications 3* (2012): 960).

These electrodes connect to BTX generators using the Tweezertrodes Connection cables (45-0204). Tweezertrodes may be cleaned with a mild detergent and sterilized with 70% ethanol or ethylene oxide.

Applications & Use

Following localized or systemic injection of the molecule of interest, the Tweezertrodes electrode disks are used to grasp the tissue of interest. An electroporation pulse is then applied; initiating pore formation and incorporation of the molecule into the cells of the tissue in direct contact with the electrode disk. Tweezertrodes can be used to facilitate localized electroporation of various preparations. Application of these electrodes for in utero transfection, transdermal drug delivery and electroporation therapy have been described. Tweezertrodes have proven particular useful for embryonic or even spermatogonial cell electroporation for effective production of transgenic and knockout mice. The design of the Tweezetrodes is also particular suited for zebrafish applications for studies aiming to rapidly study gene function in whole organism.

Specifications

Generator Compatibility	ECM 830, ECM 2001+, Gemini X2
Voltage Range	0 to 200 VDC (do not use AC current)
Pulse Length Range	1 µs to 200 ms
Pulse Number Range	1 to 99 (depending on voltage)
Operating Temperature	5°C to 40°C
Intended Use	Indoor use only
Relative Humidity	20 to 80%

Ordering Information

Item #	Description
45-2053	Platinum Tweezertrode, 1 mm Diameter
45-0486	Platinum Tweezertrode, 1 mm Diameter (includes 45-0204 cables)
45-2054	Platinum Tweezertrode, 3 mm Diameter
45-0487	Platinum Tweezertrode, 3 mm Diameter (includes 45-0204 cable)
45-2055	Platinum Tweezertrode, 5 mm Diameter
45-0489	Platinum Tweezertrode, 5 mm Diameter (includes 45-0204 cables)
45-2056	Platinum Tweezertrode, 7 mm Diameter
45-0488	Platinum Tweezertrode, 7 mm Diameter (includes 45-0204 cables)
45-0524	Platinum Tweezertrode, 1 mm Flat
45-0525	Platinum Tweezertrode Kit, 1 mm Flat (includes 45-0204 cable)
45-0118	Stainless Tweezertrode Electrode, 7 mm Diameter
45-0165	Stainless Tweezertrode Kit, 7 mm (includes 45-0204 cable)
45-0119	Stainless Tweezertrode Electrode, 10 mm Diameter
45-0166	Stainless Tweezertrode Kit, 10 mm (includes 45-0204 cable)
45-0493	Triple Electrode Tweezertrode, 3 mm
45-0494	Triple Electrode Tweezertrode, 5 mm
Required for connection to ECM 830 and Gemini X2	
45-0204	Adapter Banana Plug Cables, Red and Black
Required for connection to ECM 2001+	
45-0204	Adapter Banana Plug Cables, Red and Black
45-0088	Female/ Female Adapter Set for Banana Plug Cables
45-0083	Coaxial to Banana Plug Cables, Red and Black, 10 ft

Oocyte Electrodes

Reusable slide-type electrode for drug or gene delivery into oocytes or zygotes including CRISPR

Applications

- In vivo drug or gene delivery including CRISPR
- Transgenic animal model creation including methods using CRISPR

The Oocyte Electrode is a reusable slide type of electrode specifically designed for drug or gene delivery into oocytes and/or zygotes. This electrode can be used with a microscope so that individual oocytes can be visualized during electroporation. This electrode is particularly useful for the generation of transgenic animals including use with the CRISPR/Cas 9 construct to both knock-in and knock-out targeted genes.

The Oocyte Electrode is composed of platinum electrodes arranged in parallel with a 1 mm gap between them mounted on a glass slide. It may be cleaned with a mild detergent and sterilized with 70% ethanol. This electrode requires the use of Mini Micro-Grabber Cables and Tweezertrode Adapter Cables.

Specifications

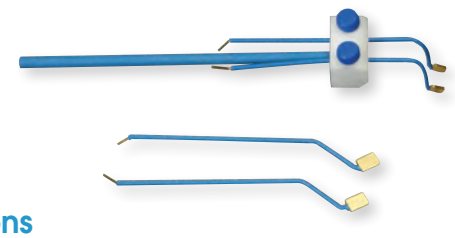
Generator Compatibility	Gemini X2, ECM 830, ECM 2001+
Voltage Range	0 to 200 VDC (Do not use AC current)
Pulse Length Range	10 µs to 10 s
Pulse Number Range	1 to 99 (depending on voltage)
Operating Temperature	5°C to 40°C
Intended Use	Indoor use only
Relative Humidity	20 to 80%

Ordering Information

Item #	Decription
45-0495	Oocyte Electrode, Platinum Plated, 10 mm, 1 mm gap (Electrode only)
45-0496	Oocyte Electrode Kit, Platinum Plated, 10 mm, 1 mm gap (with cables)
Required for connection to ECM 830 and Gemini X2	
45-0503	Micrograbber Cables for Tissue Slice Chamber
45-0204	Adapter Banana Plug Cables, Red and Black
Required for connection to ECM 2001+	
45-0503	Micrograbber Cables for Tissue Slice Chamber
45-0204	Adapter Banana Plug Cables, Red and Black
45-0088	Female/Female Adapter Set for Banana Plug Cables

Genepaddles™ Electrodes

Paddle-style reusable electrodes for in vitro embryo and in vivo gene delivery



Applications

- In vivo gene delivery
- In vitro embryo gene delivery

Genepaddles Electrodes are paddle-style reusable electrodes suitable for a variety of applications. Genepaddles come in two sizes, each size consisting of a pair of electrodes. The Genepaddles feature either rectangular 3 x 5 mm paddles or 5 x 7 mm paddles. These two sizes are designed to target various electroporation areas.

These electrodes are connected to either micrograbber connection cables or square post adaptors and connection cables which interface with our ECM 830, ECM 2001+ or Gemini X2 pulse generators. The Genepaddles are positioned in parallel at a predetermined gap within a tissue using the Genetrode Holder.

Genepaddles may be cleaned with a mild detergent and sterilized with 70% ethanol or ethylene oxide. Properly maintained Genepaddles have a life span of approximately 1500+ pulses.

Specifications

Generator Compatibility	Gemini X2, ECM 830, ECM 2001+
Voltage Range	0 to 200 VDC
Pulse Length Range	1 µs to 99 ms
Pulse Number Range	1 to 99 (depending on voltage and pulse length settings)
Total number of pulses	Approximately 1500 pulses per set of electrodes

Ordering Information

Order #	Description
45-0122	Genepaddles, 3 x 5 mm (need 45-0203 holder and 45-0216 cables)
45-0123	Genepaddles, 5 x 7 mm (need 45-0203 holder and 45-0216 cables)
45-0169	Genepaddles Kit, 3 x 5 mm (includes 45-0203 holder and 45-0216 cables)
45-0170	Genepaddles Kit, 5 x 7 mm (includes 45-0203 holder and 45-0216 cables)
45-0203	Genetrode/Genepaddle Holder
Required for connection to ECM 830 and Gemini X2	
45-0216	Micrograbber to Banana Plug Connection Cables, 10 ft
Required for connection to ECM 2001+	
45-0216	Micrograbber to Banana Plug Connection Cables, 10 ft
45-0088	Female/Female Adapter Set for Banana Plug Cables

Platinum Needle L-Shaped Electrode

Ultra thin diameter electrodes for in vivo applications using fragile tissue types

Applications

- Ex vivo tissues, gene, or drug delivery
- In vivo tissues, gene, or drug delivery
- Nuclear transfer

These 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 without damage to the tissue. The ultra thin electrode enables transfection for greater ease and efficiency in fragile or inaccessible 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 a 3 mm tip length in order to accommodate the most research needs in small animal models.

Specifications

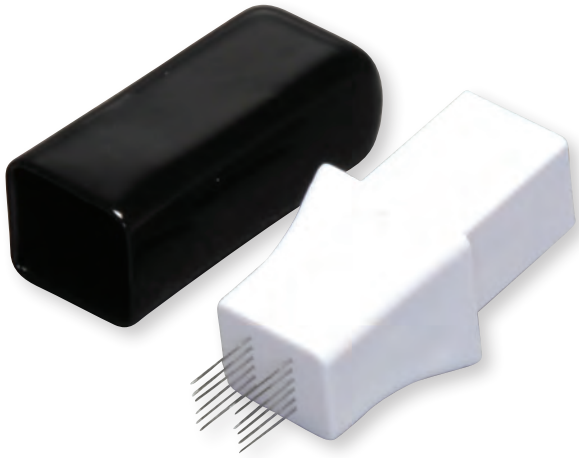
Generator Compatibility	Gemini X2, ECM 830, ECM 2001+
Voltage Range	0 to 100 VDC
Pulse Length Range	10 µs to 100 ms
Needle Length	3 mm
Electrode Length	3 mm
Electrode Material	Platinum

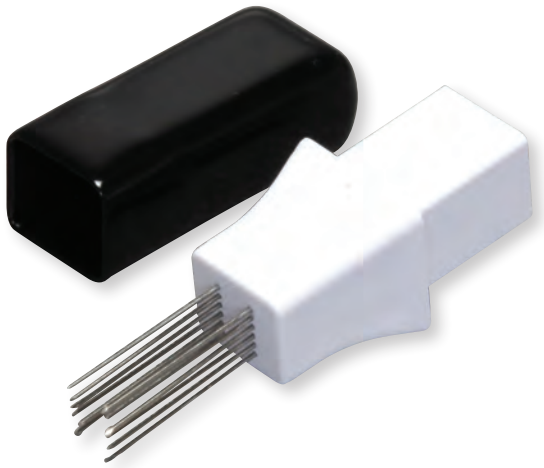
Ordering Information

Item #	Decription
45-0510	Platinum Needle L-Shaped Electrode Kit, 3 mm, includes cables
45-0509	Platinum Needle L-Shaped Electrode, 3 mm, Needle Electrode only
Required for connection to ECM 830 and Gemini X2	
45-0216	Micrograbber to Banana Plug Connection Cables, 10 ft
Required for connection to ECM 2001+	
45-0216	Micrograbber to Banana Plug Connection Cables, 10 ft
45-0088	Female/Female Adapter Set for Banana Plug Cables

AgilePulse™ Needle Array Electrodes

Specialized for gene and vaccine delivery





Applications

- DNA vaccine delivery
- Cancer vaccine research
- Intra-dermal transfection
- Gene therapy research
- Intra-muscular gene delivery
- Chemotherapeutic research

AgilePulse Needle Array Electrodes are miniature needles designed to provide superior, highly-uniform electric fields in dermal or muscular tissue as part of the AgilePulse In Vivo Gene Delivery Electroporation System. The miniature parallel-needle array is inserted directly into the target site for fast, reliable in vivo electroporation. The electric fields produced are the closest approximation of parallel plate electrodes, treating approximately 80% of the target area with 95% of the applied electric field.

The needle array requires the needle array handle, which includes the electrode connector cable. Several needle lengths and row spacing are available for various intra-dermal or intra-muscular applications. These needle arrays can be used for up to 500 pulses with proper care and maintenance.

Features

- Uniform, reliable electric fields
- Miniature needles minimize tissue trauma
- Disposable, sterile
- Medical-grade plastic and surgical steel construction
- Safety-assured design
- Multiple configurations and sizes to choose

Ordering Information

Item #	Description
47-0040	4-Needle Array, 4 mm gap, 2 mm length
47-0043	4-Needle Array, 4 mm gap, 3 mm length
47-0045	4-Needle Array, 4 mm gap, 5 mm length
47-0050	6-Needle Array, 4 mm gap, 2 mm length
47-0060	6-Needle Array, 6 mm gap, 2 mm length
47-0070	6-Needle Array, 6 mm gap, 10 mm length
47-0080	6-Needle Array, 6 mm gap, 25 mm length
47-0086	6-Needle Array, 6 mm gap, 16 mm length
47-0000	Needle Array Handle

Specifications

Item #	47-0040	47-0043	47-0045	47-0050	47-0060	47-0070	47-0080	47-0086
Needle Material	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Needle Tip	Fine Point	Fine Point	Fine Point	Fine Point	Fine Point	Fine Point	Trocar Point	Trocar Point
Spacing in Row	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm
Spacing Between Rows	4 mm	4 mm	4 mm	4 mm	6 mm	4 mm	4 mm	6 mm
Needles per Row	4	4	4	6	6	6	6	6
Needle Diameter	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.3 mm	0.7 mm	0.7 mm
Needle Length	2 mm	3 mm	5 mm	2 mm	2 mm	10 mm	25 mm	16 mm

Petri Dish Electrode

To electroporate adherent cells or tissue grown in a Petri dish that functions as the electroporation chamber

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

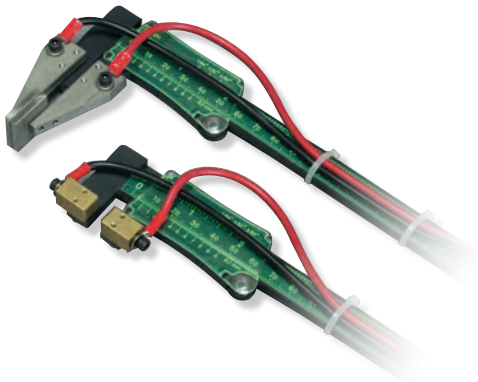
Generator Compatibility	Gemini X2, ECM 830, ECM 2001+
Voltage Range	0 to 2000 V
Volume Range	10 to 50 ml
Gap size	2 mm
Autoclavable	No
Field type	Homogeneous
Pulse Length	10 µs to 10 ms

Ordering Information

Item #	Desciption
45-0100	Petri Dish Electrode, 2 mm Gap, for 100 mm Petri Dish (Model 366)
Required for connection to ECM 2001+	
45-0088	Female/Female Adapter Set for Banana Plug Cables

Caliper Electrodes

In vivo style reusable electrodes



Applications

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

BTX Caliper Electrodes are in vivo style reusable electrodes used for a variety of applications, including drug and gene delivery. The electrodes span the target area and deliver electroporation pulses following injection of the molecule of interest. The electric field introduced by the caliper electrodes cause transient pores to form in the cells of the tissue, allowing uptake of the molecules into the cells.

Caliper electrodes are available in two sizes. Each size consists of a caliper and a pair of electrode plates. The 1.0 x 1.0 cm electrode is used in smaller animals with a smaller tissue surface area, while the 2.0 x 2.0 cm is used to target slightly larger surface areas. The end plates of the electrode may be adjusted by using the black roller mounted on the caliper. They may be cleaned with a mild detergent and sterilized with ethanol or ethylene oxide. Properly maintained caliper electrodes have an unlimited lifetime.

Specifications

Generator Compatibility	ECM 830, ECM 2001+, Gemini X2
Voltage Range	0 to 500 V
Pulse Length Range	10 µs to 99 ms (multiple pulsing permitted)
Electrode Gap	0.1 to 13 cm
Electrode Dimensions	1 x 1 cm brass or 1.5 cm x 1.5 cm and 2 x 2 stainless steel

Ordering Information

Item #	Plate Dimensions	Material
45-0101	1 x 1 cm	Brass
45-0102	1.5 x 1.5 cm and 2 x 2 cm	Stainless Steel
Item #	**Desciption**	
Required for connection to ECM 2001+		
45-0088	Female/Female Adapter Set for Banana Plug Cables	

Petri Dish Platinum Electrodes & Chambers for Tissues

Electrodes and chambers for ex vivo tissues gene or drug delivery using large or uniquely shaped tissue samples

Applications

- Ex vivo tissues gene or drug delivery

The 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, 15 mm and 5 mm, 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 homogenous field of energy for high efficiencies.

Specifications

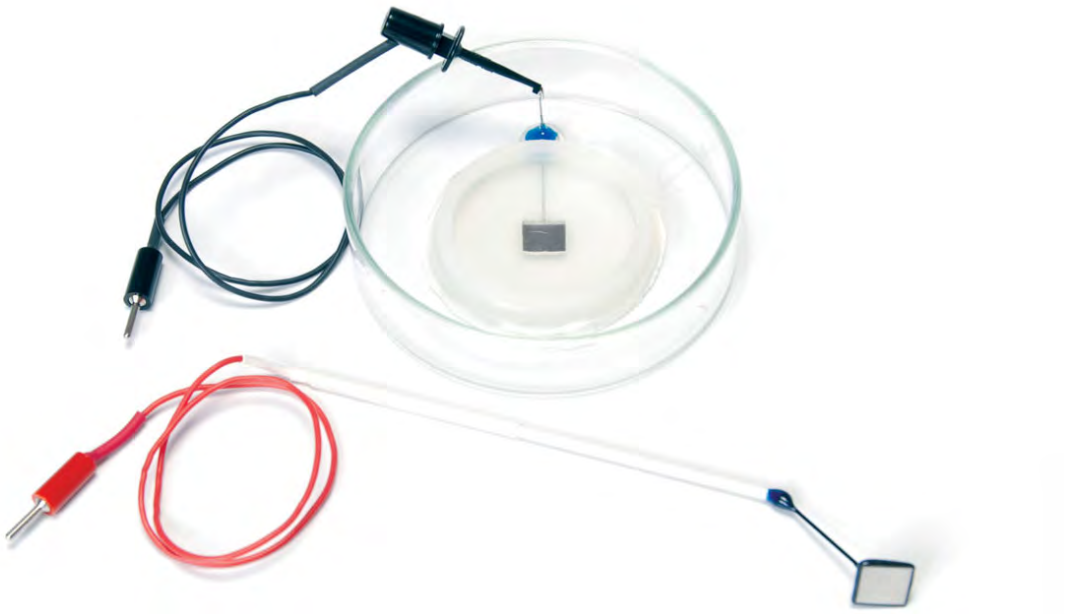
Generator Compatibility	ECM 830, ECM 2001+, Gemini X2
Voltage Range	0 to 200 V
Pulse Length	10 µs to 100 ms
Dimensions	
Chamber 5 mm gap (L x W x D)	8 mm x 5 mm x 3 mm
Chamber 15 mm gap (L x W x D)	10 mm x 15 mm x 5 mm

Ordering Information

Item #	Description
45-0505	Petri Dish Platinum Electrode for Tissues Chamber Kit, 5 mm gap
45-0507	Petri Dish Platinum Electrode for Tissues Chamber Kit, 15 mm gap
45-0504	Petri Dish Platinum Electrode Chamber, 5 mm gap
45-0506	Petri Dish Platinum Electrode Chamber, 15 mm gap
45-0513	Petri Dish Tissue Chamber Kit, 15 mm gap with cables
Required for connection to ECM 830 and Gemini X2	
45-0503	Micrograbber Cables for Tissue Slice Chamber
45-0204	Adapter Banana Plug Cables, Red and Black
Required for connection to ECM 2001+	
45-0503	Micrograbber Cables for Tissue Slice Chamber
45-0204	Adapter Banana Plug Cables, Red and Black
45-0088	Female/Female Adapter Set for Banana Plug Cables

Petri Dish Platinum Electrodes & Chambers for Tissue Slices

Electrodes and chambers for delicate and/or difficult tissue transfection



Applications

• Ex vivo electroporation

The Petri dish platiunum electrodes are designed for delicate and/or difficult ex vivo tissue transfection. Ex vivo electroporation is an efficient, effective method to introduce genes, drugs or any number of molecules into ex-plant tissues. A common application is mouse brain slice for studying neuronal development. This specialty electrode makes transfection quick and simple and is compatible with both the BTX ECM 830 and ECM 2001+ generator. The electrode is comprised of two parts, the glass Petri dish electrode and electrode wand. The glass Petri dish contains a square shaped 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

Generator Compatibility	ECM 830, ECM 2001+, Gemini X2
Voltage Range	0 to 100 V
Pulse Length Range	10 µs to 200 ms
Chamber Depth	1 to 99 (depending on voltage)
Electrode Material	5°C to 40°C
Wand Material	Platinum
Dimensions	
Dish Electode, 10 mm (L x W x D)	10 mm x 10 mm x 1 mm
Dish Electode, 7 mm (L x W x D)	7 mm x 7 mm x 1 mm
Wand Electrode, 10 mm (L x W x D)	10 mm x 10 mm
Wand Electrode, 7 mm (L x W x D)	7 mm x 7 mm

Ordering Information

Item #	Desciption
45-0500	Petri Dish Platinum Electrode for Tissue Slices Chamber Kit, 10 mm
45-0490	Petri Dish Platinum Electrode for Tissue Slices Chamber Kit, 7 mm
45-0501	Petri Dish Platinum Electrode Chamber, 10 mm, Negative
45-0491	Petri Dish Platinum Electrode Chamber, 7 mm, Negative
45-0502	Platinum Electrode Wand, 10 mm, Positive
45-0492	Platinum Electrode Wand, 7 mm, Positive
	Required for connection to ECM 830 and Gemini X2
45-0503	Micrograbber Cable for Tissue Slice Chamber, Negative
45-0204	Adapter Banana Plug Cables, Red and Black
	Required for connection to ECM 2001+
45-0503	Micrograbber Cable for Tissue Slice Chamber, Negative
45-0204	Adapter Banana Plug Cables, Red and Black
45-0088	Female/Female Adapter Set for Banana Plug Cables

Flat Electrode

Divergent field for cell fusion; homogeneous field for electroporation

Applications

- Cell fusion
- Hybridoma production
- Plant protoplast fusion
- Mammalian cell transfection

The Flat Electrode can be used for both electroporation and electro cell fusion. It 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, Gemini X2, ECM 2001+
Field Type	Divergent or homogeneous
Autoclavable	No

Ordering Information

Flat Electrode

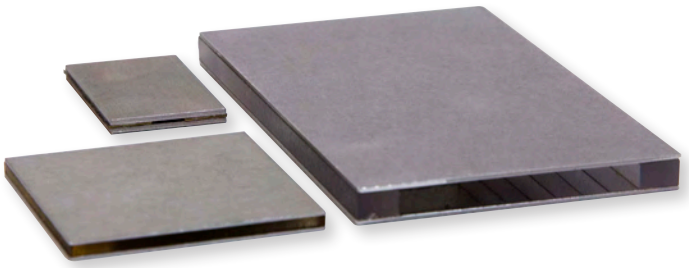
Item #	Gap	Package	Volume
45-0108	1 mm	1 each	0.5 ml

Cable

Item #	Description
Required for connection to ECM 830 and Gemini X2	
45-0217	Electrode connection cable, banana to banana, 10 ft
Required for connection to ECM 2001+	
45-0088	Female/Female Adapter Set for Banana Plug Cables
45-0217	Electrode connection cable, banana to banana, 10 ft

Flatpack Chambers

For prokaryotic (suspension) cell electroporation as well as high efficiency stem cell (eukaryotic) transfection



Applications

- Bacterial transformation
- Yeast transformation
- Stem cell transfection
- Large volume transfections

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 gap has a three-ply solid sandwich construction of stainless steel and mylar plastic holds a volume of 1.5 ml, ideal for stems cells. The Flatpack Chamber 4.0 mm gap has a volume capacity from 1-10 ml and is for use with the AgilePulse MAX or ECM 2001+ in large volume mammalian cell electroporations. Flatpack chambers are gamma sterilized in individual packages. They are provided in sets of 50 and may be used in the Safety Stand.

Specifications

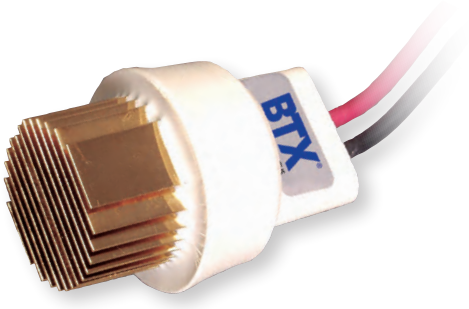
Generator Compatibility	ECM 830, ECM 2001+, Gemini X2, Agile Pulse MAX

Ordering Information

Item #	Gap Size	Package	Volume
45-0109	1.83 mm	50 each	1.5 ml
45-0110	0.56 mm	50 each	80 µl
47-0206	4.0 mm	50 each	10 ml

Petri Pulser™ Adherent Cell Electrodes

Electrode for Adherent Electroporation of 35 mm dishes



Applications

- Mammalian cell transfections
- Gene therapy, protein or drug delivery
- Plant and yeast applications

The Petri Pulser is a reusable electroporation applicator designed to fit into each single well of a 6-well plate or an individual 35 mm diameter Petri dish for the electroporation of adherent cells in situ. It consists of 13 thin gold-plated electrodes spaced 2 mm apart, designed to maximize the surface area of electroporation. The Petri Pulser is also an alternative to cuvette electroporation for larger volumes.

Specifications

Generator Compatibility	ECM 399, ECM 630, ECM 830, ECM 2000+, Gemini X2
Voltage Range	0 to 300 V
Pulse Length Range	1 µs to 35 ms
Volume Range	0.5 to 3.0 ml
Autoclavable	No
Field Type	Homogeneous
Gap Size	2 mm

Ordering Information

Item #	Description
45-0130	Petri Pulser
Required for connection to ECM 830 and Gemini X2	
45-0088	Female/Female Adapter Set for Banana Plug Cables
45-0217	Banana to Banana Cables, Red and Black, 10 ft
Required for connection to ECM 2001+	
45-0088	Female/Female Adapter Set for Banana Plug Cables

Adherent Cell Electrodes

Electrode for Adherent Electroporation of 12-well plates

Applications

- Mammalian cell transfections
- Direct electroporation of adherent cells growing on transwell filters, coverslips, or monolayers without disruption
- Plant and yeast applications

The Adherent Cell electrode is a reusable electroporation applicator designed to fit into individual wells of a 12-well plate, 6-well plate, or 35 mm diameter Petri dish. This plate electrode is specially designed to electroporate cultured monolayers of cells on laminin-coated filters, or on 12 mm polycarbonate or polyester transwell filter units (0.4 mm pore size). The Adherent Cell Electrode consists of two 7 x 19 mm parallel plate electrodes with a 5 mm gap between the plates. Each plate electrode has a 0.3 mm height insulated foot at both ends of the bottom. When the electrode is placed in a dish, a foot minimizes the damage to cells. The electrode is brought down onto the filter until it makes contact with the buffer, usually at 1 to 2 mm above the filter.

Specifications

Generator Compatibility	ECM 830, Gemini X2, ECM 2001+
Pulse Length Range	1 µs to 35 ms
Voltage Range	0 to 300 V
Volume Range	0.5 to 3.0 ml
Autoclavable	No
Field Type	Homogeneous
Gap Size	5 mm

Ordering Information

Item #	Description
45-0530	Adherent Cell Electrode, 5 mm gap
45-0531	Adherent Cell Electrode Kit, 5 mm gap, includes 45-0204 cable
Required for connection to ECM 830 and Gemini X2	
45-0204	Adapter, Banana Plug, Cables, Red and Black
Required for connection to ECM 2001+	
45-0204	Adapter, Banana Plug, Cables, Red and Black
45-0088	Female/Female Adapter Set for Banana Plug Cables

Meander Fusion Chamber

Novel microslide for electro cell fusion

The BTX Meander Fusion Chamber is a novel microslide design which is specifically used for electro cell fusion. It generates a divergent field and is used for fusion of mammalian cells, plant, yeast, fungi and microorganisms. It allows direct viewing of dimer formation during alignment.

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 Konidaris et al. (2003) used the Meander Fusion chamber to generate Glutamic Acid Decarboxylase-specific monoclonal antibodies for studying the role autoantigens involved in type 1 diabetes mellitus. (Konidaris C, et al. No Specific Reactivity to E. coli Glutamic Acid Decarboxylase from Sera of Newly-Diagnosed Insulin Dependent Diabetic Patients. International journal of immunopathology and pharmacology. 2003; 16(2): 129-138.)

Specifications

Generator Compatibility	ECM 2001+, ECM 830, Gemini X2
Field Type	Divergent
Max Voltage:	
AC	16 V (0 to peak)
DC	0 to 480 V
Pulse Length	1 µs to 99 ms
Number of Pulses	1 to 99 (depending on voltage)
Gap Size	0.2 mm
Autoclavable	No

Ordering Information

Item #	Description
45-0107	Meander Fusion Chamber, 0.2 mm Gap, pkg. of 4
Required for connection to ECM 830 and Gemini X2	
45-0216	Micrograbber to Banana Plug Connection Cables, 10 ft
Required for connection to ECM 2001+	
45-0087	Micrograbber Adapters, Red and Black

Glass Microslides

Easily fit on a microscope stage

BTX Microslides are used for cell fusion, plant protplast fusion and embryo manipulation applications. They are available in four 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. The 3.2 and 10 mm slides provide a homogenous field for high fusion rates of hybridoma cells. The Microslides 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

Generator Compatibility	ECM 2001+, Gemini X2, ECM 830
Field Type	
45-0103 and 45-0104	Divergent
45-0105 and 45-0104	Homogeneous
Max Voltage	500 V
Autoclavable	No

Ordering Information

Item #	Description
45-0103	Microslide 0.5 mm Gap, 20 µl, pkg. of 10 (Model 450)
45-0104	Microslide 1.0 mm Gap, 20 µl, pkg. of 10 (Model 450-1)
45-0105	Microslide 3.2 mm Gap, 20 µl, pkg. of 10 (Model 453)
45-0106	Microslide 10 mm Gap, 20 µl, pkg. of 10 (Model 453-10)
45-0216	Connection Cable, Micrograbber to Banana Plug Cable
Required for connection to ECM 830 and Gemini X2	
45-0216	Micrograbber to Banana Plug Connection Cables, 10 ft
Required for connection to ECM 2001+	
45-0087	Micrograbber Adapters, Red and Black

Buffers & Accessories

Specially formulated BTXpress® electroporation and cytofusion buffers promote efficiency and preserve cell viability. The wide range of accessories featured in this section, including cuvettes, safety stands, electroporation plates, and plate handlers, lets you set up an entire system to suit your lab's needs.

BTXpress® Cytofusion™ Medium C

Designed to promote efficiency while preserving high cell viability during cell fusion

Applications

- Cell Fusion

Features

- Optimized for eukaryotic electrofusion applications
- Maximum fusion efficiency, high cell viability
- Stable environment for cell allignment
- Low conductivity means minimal heating
- Physiological pH and balanced osmolarity
- Contains no animal products

BTXpress® Cytofusion™ Medium C is an advanced electrofusion buffer designed especially for hybridoma production. The low conductivity buffer is specially formulated to minimize cell turbulence during cell alignment and heating during electrofusion, for robust cell fusion efficiency and high cell viability.

BTXpress Cytofusion Medium C is sterile filtered from the highest quality non-animal, medical-grade reagents. It is the buffer of choice for many commercial biotech and pharmaceutical companies in their hybridoma generation process for monoclonal antibody discovery.

Recommendations for Use

Maintain a sterile environment. Standard aseptic techniques are recommended to avoid contamination during use.

Thorough, repeated washing. BTXpress Cytofusion Medium C, is a low conductivity medium designed for efficient electrofusion. Trace amounts of high conductivity solutions such as PBS or tissue culture growth medium can disrupt the fusion process. Therefore, it is critical to wash the cells thoroughly with BTXpress Cytofusion Medium C prior to the fusion process. For up to 5 x 10^7 cells, at least two washes in BTXpress Cytofusion Medium C are recommended. For more than 5 x 10^7 cells, at least three washes are recommended.

Specifications

Volume	500 ml
Osmolarity	270 to 290 mOsm/L
Conductivity @ 25°C	0.080 ± 0.005 mS/cm
pH	7.2 ± 0.2
Endotoxin	<0.25 EU/ml Sterility
Sterility	Sterile filtered
Storage	2 to 8 °C
Shelf-life	18 months from production date (shipped within 6 months of production)

Thoroughly clean electrofusion chamber. To avoid other sources of ionic contamination, clean the electrofusion chamber after each use and rinse thoroughly with sterile, deionized water.

Room temperature electrofusion. For maximum efficiency cell fusion, use BTXpress Cytofusion Medium C at room temperature. Cell washes prior to the final wash may be carried out at 4°C.

Minimize time in buffer. While Cytofusion Medium C is non-toxic, it does not contain nutrients to support cell viability over long periods of time. For best results, minimize the time that cells are suspended in BTXpress Cytofusion Medium C. It is not recommended that cells remain in BTXpress Cytofusion Medium C longer than one hour subsequent to the final wash.

5:1 direct dilution. Post-electrofusion, cells in BTXpress Cytofusion Medium C can be diluted in cell culture medium without washing the cells. A minimum dilution of five parts complete culture medium to one part BTXpress Cytofusion Medium C is recommended. Alternatively, cells may be washed in growth medium to completely remove BTXpress Cytofusion Medium C prior to culturing.

Storage Information

Store at 2 to 8°C after opening. Short term storage (i.e. for shipping) at -20°C to +50°C for 7 days is acceptable. Contents may separate upon freezing. If frozen, mix well before use.

Warnings & Disclaimers

Do not use if tamper-proof seal is missing or bottle is damaged. Damage to the bottle or deliberate tampering may result in contamination of this product. Check product for clarity before use. It is not intended for human use. This product is not considered to be hazardous based on evaluations made under OSHA Hazard Communication Standard 29 CFR 1910.1200.

Ordering Information

Item #	Description
45-0803	BTXpress Cytofusion Electroporation Medium C, 500 ml

BTXpress® Electroporation Solution

Single buffer solution quickly and efficiently delivers genes into mammalian cells

Applications

- Transfection

Features

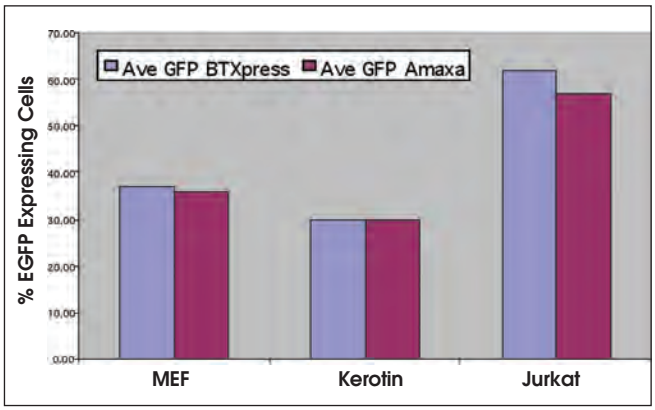
- Efficient electroporation transfection
- High efficiency transfection of difficult cell lines
- High cell viability, low toxicity
- Single buffer for all mammalian cell types
- One buffer used in place of standard electroporation buffers for all mammalian cell types

BTXpress Electroporation Solution is 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 electroporation systems, 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.

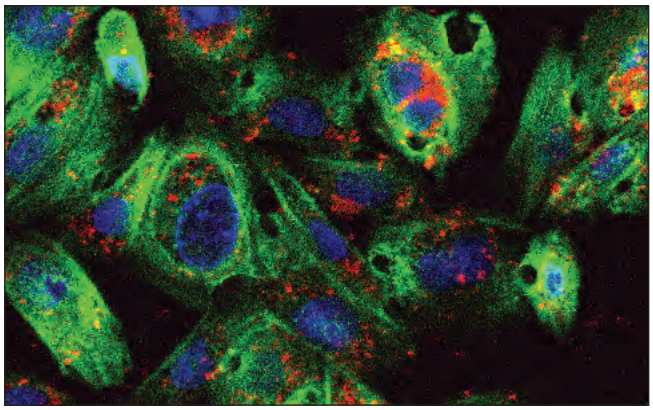
BTXpress Electroporation Solution is the first electroporation reagent that meets all of your high performance transfection needs without sacrificing control over your experiment or your budget. It offers increased numbers of transfections per kit compared to other commercial alternatives, providing higher value to you. As a universal solution, the BTXpress Electroporation Solution 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 Electroporation Solution is offered as a kit including the BTX Cuvettes Plus with transfer pipettes or as a buffer alone.

Please Note: Amaxa is a registered trademark of Lonza.

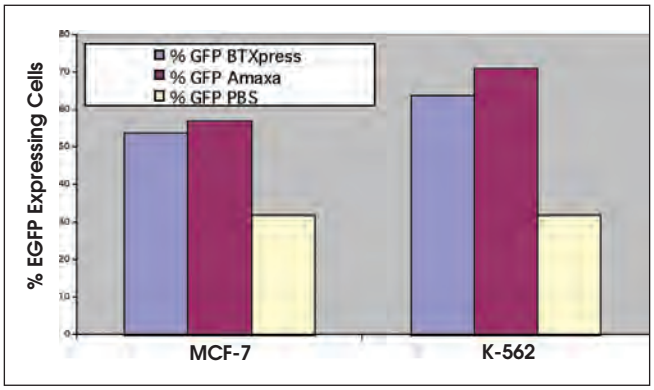
Typical Results



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 24 hrs post-electroporation by flow cytometery and presented as a percentage of the live cell population.*



BTXpress® High Performance Electroporation Solution Efficient siRNA silencing: CHO Cells were transfected by electroporation with BTXpress® electroporation solution with tracker Cy3-labeled siRNA. Cells were fixed and counterstained to locate the nuclei (blue) and actin (green).



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 cytometery and presented as a percentage of the live cell population.*

Ordering Information

Item #	Description	Included Items
45-0803	BTXpress Solution Kit 50 Reactions in 2 mm gap Cuvettes	5 mL bottle BTXpress solution and 5 bags (10 cuvettes/bag) of 2 mm gap BTXplus cuvettes with transfer pipette
45-0804	BTXpress Solution Kit 20 Reactions in 4 mm gap Cuvettes	5 mL bottle BTXpress solution and 2 bags of (10 cuvettes/bag) of 4mm gap BTXplus cuvettes with transfer pipette
45-0806	BTXpress Solution Kit 100 Reactions in 2 mm gap Cuvettes	10 mL bottle of BTXpress solution and 2 bags (50 cuvettes/bag) of 2 mm gap BTXplus cuvettes with transfer pipette
45-0807	BTXpress Solution Kit 40 Reactions in 4 mm gap Cuvettes	10 mL bottle of BTXpress solution and 4 bags (10 cuvettes/bag) of 4 mm gap BTXplus cuvettes with transfer pipette
45-0802	BTXpress Solution 5 mL	5 mL bottle for up to 50 reactions
45-0805	BTXpress Solution 10 mL	10 mL bottle for up to 100 reactions

BTXpress® Cytoporation™ Media T and T4

Advanced electroporation buffers designed for use with the AgilePulse MAX

Features

- Optimized for eukaryotic electrofusion applications
- Maximum transfection efficiency, high cell viability
- Low conductiveity means minimal heating and electrode arcing
- Two formulations available—optimized conductivity to cell type
- Physiological pH and balanced osmolarity
- Contains no animal products
- Certified RNase and DNase free

Advanced Buffer for High Performance Transfection

BTXpress Cytporation™ Media T and T4 are advanced electroporation buffers designed for use with the AgilePulse Max Large Volume Electroporation System for ex vivo add in vitro delivery of DNA, RNA, oligonucleotides, and siRNA. The low conductivity buffer is specially formulated to minimize heating of solutions during large volume electroporation for maximum transfection efficiency and high cell viability.

BTXpress Cytporation Media are sterile filtered from the highest quality non-animal, medical-grade reagents. Two formulations with different conductivities are available for optimum conductivity for each eukaryotic cell type. Buffer can be directly diluted in complete growth media for post-electroporation cell culture.

Recommendations For Use

Maintain a sterile environment. Standard aseptic techniques are recommended to avoid contamination during use.

Thorough, repeated washing. Cytoporation Media T and T4 are low-conductivity solutions designed for efficient electroporation. Trace amounts of high conductivity solutions such as PBS or tissue culture growth media can disrupt the electroporation process. Therefore, at least two full washes of Cytoporation Media T or T4 are recommended prior to electroporation.

Specifications

Volume	500 ml
Osmolarity	270 to 290 mOsm/L
Conductivity @ 25°C	
Cytoporation Medium T	0.080 ± 0.005 ms/cm
Cytoporation Medium T4	3.45 ± 0.05 ms/cm
pH	7.2 ± 0.2
RNase	None detected
DNase	None detected
Endotoxin	<0.25 EU/ml
Sterility	Sterile filtered
Storage	2 to 8°C

5:1 direct dilution. Post-electroporation, Cytoporation Media T and T4 can be directly diluted in cell culture media without washing the cells. A minimum dilution of five parts complete culture media to one part Cytoporation Media T or T4 is recommended. Alternatively, cells may be washed in growth media to completely remove Cytoporation Media T or T4 prior to culturing.

Storage Information

Store at 2 to 8°C after opening. Short-term storage (i.e. for shipping) at 20°C to +50°C for 7 days is acceptable. Contents may separate upon freezing. If frozen, mix well before use.

Warnings & Disclaimers

Do not use if tamper-proof seal is missing or bottle is damaged. Damage to the bottle or deliberate tampering may result in contamination of this product. Check product for clarity before use. BTXpress Cytoporation Media T and T4 are not intended for human use. This product is not considered to be hazardous based on evaluations made under OSHA Hazard Communication Standard 29 CFR 1910.1200.

Ordering Information

Item #	Description
47-0002	BTXpress Cytofusion Media T, 500 ml
47-0003	BTXpress Cytofusion Media T4, 500 ml

Electroporation Cuvettes Plus

For use in electroporation and electrofusion of bacteria, yeast, insect, plant and mammalian cells

Applications

- Bacteria
- Yeast
- Insect
- Plant
- Mammalian cells

Features

- Cuvettes and safety stand protect both user and sample
- Compatible with many commercially available electroporators

BTX Electroporation Cuvettes Plus are designed for use in electroporation and electrofusion of bacteria, yeast, insect, plant and mammalian cells.

Each sterilized Cuvettes Plus package includes a disposable cuvette and a sterile transfer pipette, which allows for quick and easy removal of the sample after electroporation. The cuvettes are molded with embedded polished aluminum electrodes, and gamma irradiated for guaranteed sterility. BTX cuvettes can obtain high field strengths up to 25.0 kV/cm.

Three electrode gap sizes are available, 1 mm for bacteria and yeast, 2 mm for all cell types, and 4 mm for mammalian cells. Round cuvette caps are leak resistant and allow for quick and easy one-finger removal. A 20-position cuvette rack is available separately.

BTX disposable Cuvettes Plus require no maintenance. Simply discard carefully after use. For research use only.

Specifications

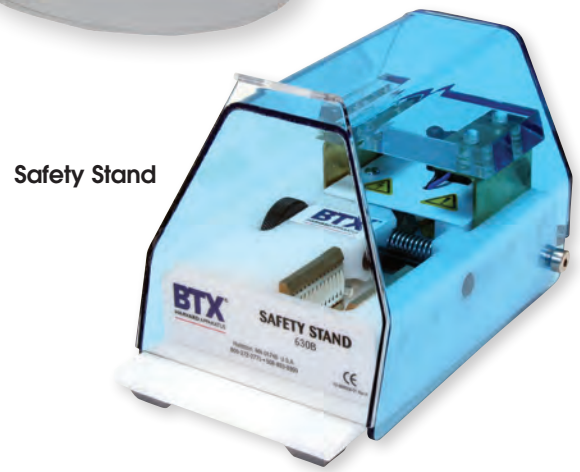
Item #	45-0134/0124/0140	45-0135/0125/0141	45-0136/0126/0142
Model	610	620	640
Cap Color	Gray	Blue	Yellow
Gap (mm)	1.0	2.0	3.0
Field Type	Homogeneous	Homogeneous	Homogeneous
Autoclavable	No	No	No
Sample Visibility	Yes	Yes	Yes
Minimum Volume	20 µL	40 µL	80 µL
Maximum Volume	90 µL	400 µL	800 µL

Ordering Information

Item #	Description
45-0134	Cuvette Plus, 1 mm gap, 90 µl, Sterile Pkg/10, Gray
45-0124	Cuvette Plus, 1 mm gap, 90 µl, Sterile Pkg/50, Gray
45-0140	Cuvette Plus, 1 mm gap, 90 µl, Sterile, 24 Pkg/100 each, Gray
45-0135	Cuvette Plus, 2 mm gap, 400 µl, Sterile Pkg/10, Blue
45-0125	Cuvette Plus, 2 mm gap, 400 µl, Sterile Pkg/50, Blue
45-0141	Cuvette Plus, 2 mm gap, 400 µl, Sterile, 24 Pkg/100 each, Blue
45-0136	Cuvette Plus, 4 mm gap, 800 µl, Sterile Pkg/10, Yellow
45-0126	Cuvette Plus, 4 mm gap, 800 µl, Sterile Pkg/50, Yellow
45-0142	Cuvette Plus, 4 mm gap, 800 µl, Sterile, 24 Pkg/100 each, Yellow
45-0208	Cuvette Rack, 20 Numbered Positions

Safety Stands and Domes for Cuvettes & Chambers

Ensure safe delivery of HV electrical pulses



Safety stands and safety domes connect to any generator allowing the safe delivery of HV electrical pulses to cuvettes. Up to two cuvettes may be electroporated simultaneously in a safety stand or safety dome.

Ordering Information

Item #	Description
45-0207	Safety Stand, Adjustable Gap for cuvettes for use with ECM 630, ECM 830, Gemini and ECM 2001+
47-0205	Electroporation Safety Stand for 6 ml Chambers for use with ECM 2001+
47-0208	Safety Stand for Flatpack for use with ECM 630, ECM 830, Gemini and ECM 2001+
47-0203	AgilePulse MAX Safety Stand for Cuvettes
47-0209	AgilePulse MAX Safety Stand for Flatpack
47-0202N	AgilePulse MAX Stand for Large Volume (6 ml) Chambers
45-2021	Safety Dome for the ECM 630, ECM 830 and Gemini X2
45-2020	Safety Dome for the Gemini SC
45-0208	Cuvette Rack, 20 Numbered Positions

Personal Electroporation Pak Cuvette Module (PEP)

Self-contained portable single cuvette module for connection to a BTX Electroporation System

The PEP (Personal Electroporation Pak) is a self-contained portable cuvette module compatible with the ECM 399, ECM 630, ECM 830 and ECM 2001+. The PEP connects to these generators, allowing the safe delivery of HV electrical pulses to cuvettes.

The PEP holds one cuvette and is an ideal solution for quick singular transfections. Connection cables are not required.

Specifications*

Voltage Range	0 to 3000 VDC
Pulse Length/Time Constants Range	5 ms to 125 ms
Pulse Number Range	1
Operating Temperature	5° to 40°C
Intended Use	Indoor use only
Relative Humidity	20 to 80%
Maximum Altitude	2,000 m (6,562 ft)
Pollution Degree	II
Insulation Category	CAT I
Physical Characteristics	
Overall Dimensions	8.3 x 5.6 x 8.3 cm (3.25 x 2.19 x 3.25 in)
Weight	0.01 kg (0.22 lb)

**Note: Depending on buffer compostion and volume.*

Ordering Information

Item #	Description
45-0212	PEP Personal Electroporation Pak Cuvette Module

High Throughput Plate Handlers

Create a safe and reliable working area for processing electroporation plates

Applications

Mammalian Cell Transfection:

- siRNA
- Plasmid DNA
- cDNA libraries
- Gene knockdown or overexpression screens

Transformation of Bacteria and Yeast:

- BAC library
- Plasmid DNA

The High Throughput Plate Handlers create a safe and reliable working area for processing multi-well electroporation plates. They are ideal for use with the ECM 630, ECM 830 and Gemini X2 systems.

The HT-100 and HT-200 Plate Handlers have pulse switching technology integrated into the package and gold plated contacts to mate with a 96-well electroporation plate. The plate handler delivers a single pulse to the wells of the plate, column by column, using parameters set in the generator. The HT-100 uses manual track switching, while the HT-200 employs auto-sense track switching. Both plate handlers work with 96-well plates and come with an adapter to accommodate 25-well plates.

Specifications

Item #	Description
Power	100 to 240 VAC, 50/60 Hz, 15 W, 0.50 A fuse (2)
Voltage Range	0 to 3000 VDC (Pulse)
Pulse Length Range	10 µs to 10 s
Pulse Number Range	1 to 99
Operating Temperature	5° to 40°C
Intended Use	Indoor Use
Relative Humidity	20 to 80%
Maximum Altitude	2,000 m (6,562 ft)
Pollution Degree	II
Insulation Degree	Cat I
Width x Depth x Height	23 x 21.5 x 14 cm (9.1 x 8.5 x 5.5 in)
Weight	4.8 kg (10.6 lb)

Features

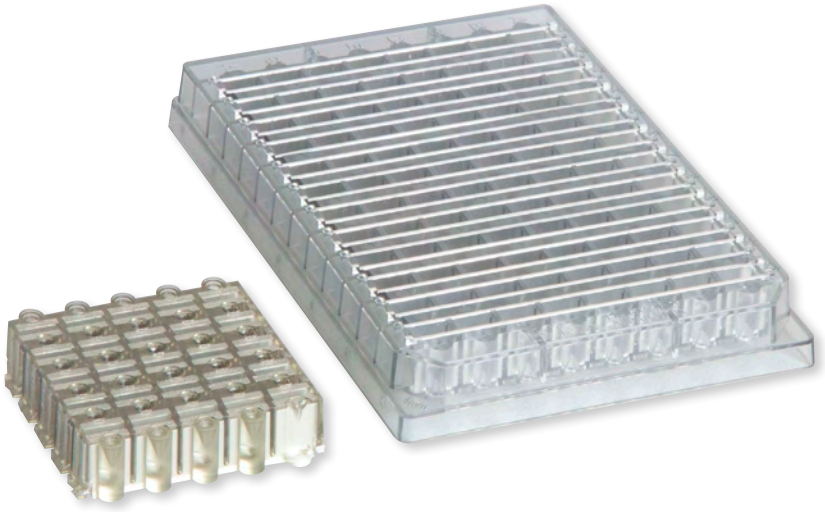
- Quickly optimize for better gene delivery
- Process up to 96 wells in seconds
- Compatible with any electroporation buffer
- Include connectors for standard pulse generators

Ordering Information

Item #	Description
45-0400	HT-100 Plate Handler, Manual Track Switching (N. America)
45-0401	HT-200 Plate Handler, Auto-Sense Track Switching (N. America)
45-0465	25-Well Plate Adaptor for Plate Handlers

High Throughput Electroporation Plates

Sterile multi-well electroporation plates for transfection/transformation of bacteria, yeast, insect, plant and mammalian cells



Applications

- Transfection/transformation of bacteria, plant and mammalian cell types
- siRNA transfections
- Library studies
- Stem cell projects

Features

- Standard multi-well formats
- Bio-compatible materials

BTX High Throughput Electroporation Plates are sterile multi-well electroporation plates for transfection or transformation of bacteria, yeast, insect, plant and mammalian cells.

Try out many different electroporation conditions (cell density, buffer, pulse voltage and width, etc.) to find the highest transfection efficiency, quickly and easily, with the ECM 830 HT Electroporation System, the ECM 630 HT Electroporation System, or the Gemini X2 Electroporation System. The disposable, sterile multi-well plate is the heart of the system. It's like 96 electroporation cuvettes in one convenient plate.

Ordering Information

Item #	Description
45-0466	25-Well Disposable Electroporation Plate, 2 mm gap, 125 µl, coated, 1 plate
45-0466-M	25-Well Disposable Electroporation Plate, 2 mm gap, 125 µl,1 plate
45-0467	25-Well Disposable Electroporation Plate, 2 mm gap, 125 µl, pkg. of 6
45-0462	25-Well Disposable Electroporation Plate, 4 mm gap, 250 µl, 1 plate
45-0463	25-Well Disposable Electroporation Plate, 4 mm gap, 250 µl, pkg. of 6

Item #	Description
45-0450	96-Well Disposable Electroporation Plate, 2 mm gap, 125 µl,coated, 1 plate
45-0450-M	96-Well Disposable Electroporation Plate, 2 mm gap, 125 µl, 1 plate
45-0452	96-Well Disposable Electroporation Plates, 4 mm gap, 250 µl, 1 plate
45-0012	25-Well Plate Seal (1)
45-0015	96-Well Plate Seal (1)

Cables & Adapters

Cables and adapters are needed to connect an electrofusion/electroporation system to the electrodes and chambers to be used for a particular application. Please visit www.btxonline.com for more detailed information on using cables and adapters to connect electrodes our systems.

45-0217
Banana to Banana Cables, 10ft

45-0089
Square Post Cable Adapter

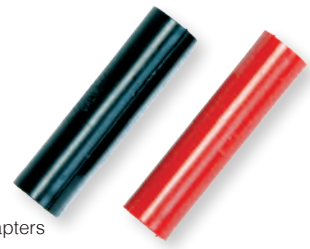
45-0083
Coaxial Cables

45-0216
Micrograbber Cables

45-0465
Well Plate Adapter

45-0204
Tweezertrode Cable Adapters

45-0087
Micrograbber Adapters



45-0088
Female/Female Adapters

Ordering Information

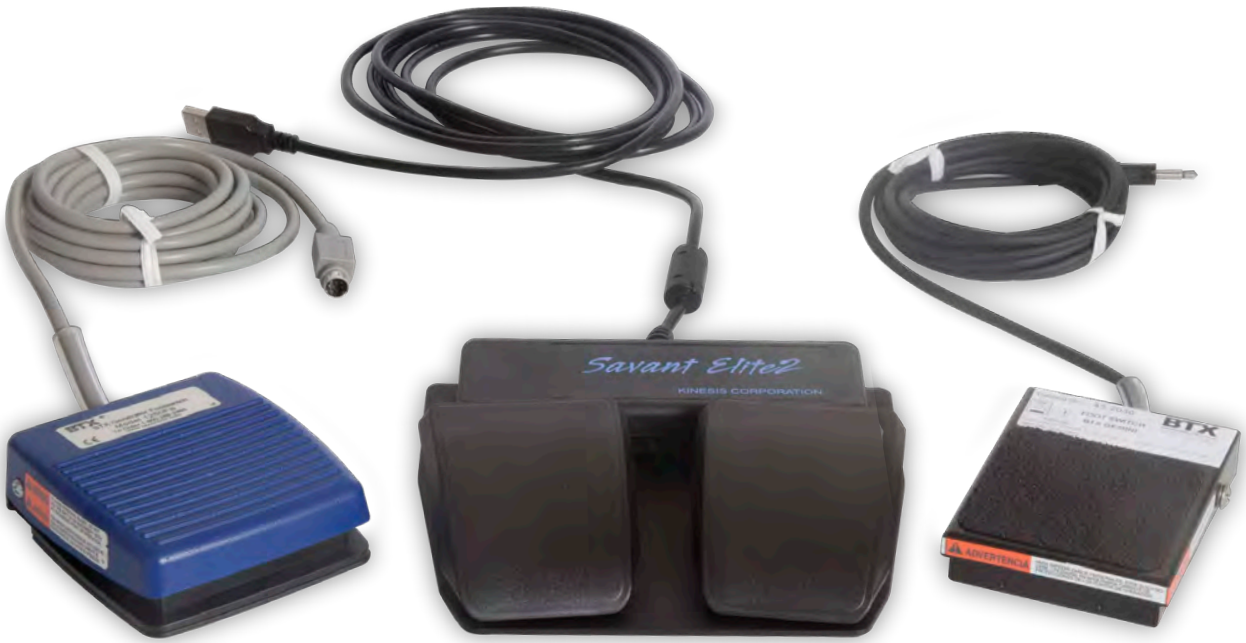
Item #	Description	System/Electrode Compatibility
45-0465	25-Well Plate Adaptor for Plate Handlers	HT-100, HT-200
45-0066	Cable Set, HV, Red and Black, 3 ft	Enhancer 3000
45-0082	Cable Set, HV, Red and Black, 1 M	Legacy ECM 2001
45-0083	Coaxial to Banana Plug Cables, Red and Black, 10 ft	Legacy ECM 2001
45-0087*	Micrograbber Adapters, Red and Black, for Banana Plug Cable 45-0217 and 45-0083	ECM 2001+, Genetrode, Genepaddle, Tissue Petri Dish Electrodes
45-0088	Female/Female Adapter Set for Banana Plug Cables 45-0216	ECM 2001+, ECM 830, Gemini X2
45-0089	Square Post Adapters, Red and Black, to Banana Plug Cables 45-0217	ECM 2001+, ECM 830, Gemini X2
45-0090	Electrode Adapter Set Banana to Pin Tip	ECM 830
45-0204	Adapter Banana Plug Cables, Red and Black	Tweezertrodes, L-Shaped Genetrode Electrodes

Item #	Description	System/Electrode Compatibility
45-0216	Micrograbber to Banana Plug Connection Cables, 10 ft	ECM 830, Gemini X2, Microslides, Genetrodes, Tissue Petri Dish Electrodes
45-0217*	Banana to Banana Cables, Red and Black, 10 ft	ECM 2001+, Gemini X2, ECM 830, Flat Electrodes
45-0503	Micrograbber Cable for Tissue Slice Chamber, Negative	Tissue Slice Chamber, Oocyte, L-Shaped Genetrodes Electrodes
45-0511	Single Adapter Cable for Wand Electrode, Positive	Tissue Slice Electrodes
45-2031	Gemini USB Cable, 2 M, Type A-B	Gemini
45-2032	Gemini USB Cable, 5 M, Type A-B	Gemini
47-0302	Hybrimune Chamber Cable	Hybrimune
47-0090	AgilePulse Adapter Box	AgilePulse ID AgilePulse IM Tweezertrodes
45-2057	High Voltage Output Cable, 5 ft	ECM 2001+
45-2058	High Voltage Output Cable, 10 ft	ECM 2001+

*Please note: If you have 45-0217 flat electrode cables, simply add/combine with 45-0087 micrograbber adapters to create micrograbber cables.

Foot Pedals & Foot Switches

For hands-free system operation



Legacy ECM 830 Foot Pedal

AgilePulse Foot Pedal

Gemini X2, ECM 830,
ECM 2001+ Foot Pedal

The Foot Pedal and Foot Switches allow for hands free operation of the ECM 830, ECM 2001+, AgilePulse and Gemini X2 generators. These accessories are desirable when conducting in vivo/in ovo gene delivery or nuclear transfer/ cloning when both hands are needed for sample manipulation.

The foot switch and foot pedal function like the “Start” button on the front of the generator. Once all the parameters are dialed in, simply press and release to activate pulse delivery or abort a pulse sequence.

Ordering Information

Item #	Descriptions
47-0420	AgilePulse Foot Pedal
45-0211	Legacy ECM 830 Foot Pedal
45-2030	Gemini X2, ECM 830, ECM 2001+ Foot Pedal
45-0086	Legacy ECM 2001 CE Footswitch with 45-0085 cable

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