1. EC21 Dimmer Rack(s)

1.1 General

1.1.1 The dimmer racks shall be fully digital, designed specifically for entertainment lighting, and shall consist of up to 48 dimmer module spaces. Dimmer rack systems shall be UL, CUL, VDE, TUV listed and CE marked devices.

1.1.2 Rack setup and preset data shall, as standard, be fully user programmable on a per rack or system wide basis. The dimmer rack shall report rack status to a remote personal computer or control console and, as an option, report dimmer status information.

1.2 Mechanical

1.2.1 The dimmer rack shall be a freestanding, dead front switchboard, substantially framed and enclosed with 16-gauge, formed steel panels. All rack components shall be properly treated, primed and finished in fine texture, scratch resistant, coating.

1.2.2 The 48 module dimmer rack shall not exceed 2032mm(h) x 623mm(w) x 660mm(d). Racks shall be designed to allow for adjacent mounting and for bolting to the floor.
The 36 dimmer module rack consisting of up to 36 module spaces, shall not exceed 1700mm(h) x 623mm(w) x 660mm(d).
The 24 dimmer module version, consisting of up to 24 dimmer module spaces, shall not exceed 1448mm (h) x 623mm(w) x 660mm(d).
Rack doors shall not increase the total rack depth by more than 60mm.

1.2.3 The rack shall be designed to allow for easy insertion and removal of all modules without the use of tools. Optional dimmer row tie down bars shall be available to mechanically block each row of six dimmer modules into the rack and requiring the use of a tool. Dimmer supports shall be provided for precise alignment of dimmer modules into power and signal connector blocks.

1.2.4 Rack spaces shall be mechanically keyed such that modules of greater current capacity cannot be accepted for that space. Racks that allow modules of higher wattage to plug into the same space shall not be acceptable.

1.2.5 Multiple low-noise fans shall be provided to allow redundancy in case of fan failure. The fans shall maintain the temperature of all components at proper operating levels with dimmers at any load, providing the ambient temperature of the dimmer room does not exceed 35 degrees Celsius. Air shall flow over the surfaces of the heat generating components using a combination of convection and fan assisted airflow. Each rack shall be outfitted with a lockable door that does not impede airflow in any manner.

1.2.6 Fans shall be gradually controlled between off and full speed in order to minimize fan noise under all operating conditions. In the event of a rack over temperature condition, a warning shall be displayed on the rack LCD display and remote personal computer (via web browser) and control console (via web browser). If the temperature rises 5 degrees C over the warning threshold, the system shall shutdown to prevent damage to components.

1.2.7 Load terminations shall be clearly marked with the rack circuit number. Signal terminations shall be by plug-in screw terminals to facilitate contracting and servicing and shall be clearly labeled. Rear access shall not be required for rack installation and termination.

1.2.8 Module numbering shall be clearly marked via a numbering strip on the front of the dimmer module tray. Standard number strips shall be available in two channel module

configurations for dimmer ranges 1-384. Custom lamacoid number strips may be used on larger installations.

1.3 Electrical

1.3.1 Dimmer racks shall operate at 90 to 264VAC 3- phase, 4 wire + ground or 90 to 264VAC, 1 phase, 2 wire + ground, 47 - 63 Hz at a maximum of 800A per phase.

1.3.2 Load phase, neutral, and ground terminals shall, as standard accept up to a 16mm^2 gauge wire. An optional terminal adapter accepting up to 35mm^2 gauge wire shall be provided to minimize load voltage losses. The fault current protection of the rack shall be 50,000 AIC. Provisions shall be made for optional amp trap devices to provide 100,000 AIC fault current protection, if required.

1.4 Rack Electronics, Physical

1.4.1 The main dimmer control electronics shall be housed in one 96-Output Rack Processor Module (RPM) plug in module. For racks with more than 96 outputs, an expanded RPM (capable of controlling up to 144 dimmers) may be installed in the dimmer rack. The dimmer control electronics shall be completely digital without employing any digital to analog demultiplexing schemes or analog ramping circuits.

1.4.2 All rack setup and preset data shall be stored in a non-volatile manner and may be transferred to a replacement Rack Processor Module without losing data.

1.4.3 Each Rack Processor Module shall have a back-lit LCD display with a six key (minimum) keypad for rack setup, preset control, testing, rack status, error and diagnostics. Bi-Color LEDs shall indicate “Network Connection”, “DMX512 Port A”, “DMX512 Port B”, “Processor OK”, “Module Event”, “Panic”, “Over temperature” “Phase A”, “Phase B”, “Phase C”, “Active Processor”.

1.4.4 An optional backup Rack Processor Module shall provide full redundant tracking processor functions. The backup RPM shall be interchangeable with the main RPM. The Backup RPM shall track all setup, preset and other commands at all times without any operator action. The Backup RPM shall take over all communications and dimming control upon activation.

1.4.5 All rack setup and preset data shall be electronically transferable between the main Rack Processor Module and the backup RPM in case of replacing either of the modules. Replacement RPM’s can download their system configuration information from the rack back plane or an optional network server. Rack set up data shall be stored in non volatile memory.

1.4.6 All rack setup and preset data shall be transferable to and from a networked library storage device on a per rack or system wide basis.

1.4.7 The Rack Processor Module shall reside in a permanently mounted Rack Processor Housing (RPH). The RPH shall provide signal connections in conjunction with optional power supply units. The RPH shall provide the only point for contractor connection of signal cables and PANIC activation. The contractor connections shall be made with two part plug in screw terminals (dedicated connector per input) or crimped RJ45 connectors for ease of installation. The RPH shall feature an available integrated four port Ethernet switch to permit the cross connection of multiple dimmer racks in a single dimmer room. RPH to RPH Ethernet connections shall be made with pre-made RJ45 patch cables.

1.4.8 All DMX512 & RS485 communication ports and remote contact input connections shall be optically isolated from all processor electronics by a minimum of 2,500V RMS isolation.

1.4.9 The Rack Processor Housing shall have the provision to select any of a maximum of 144 dimmer outputs to be activated by the PANIC function. The PANIC function shall be activated or de-activated by one or more local or remote contact closures. The RPH shall provide a selection device to enable or disable the activation of PANIC when removing the RPM from an active rack. PANIC will not be automatically activated if an RPM is removed from an inactive dimmer rack. Racks that employ processor controlled PANIC functions shall not be acceptable.

1.5 Rack Electronics, Control and Communications

1.5.1 The control electronics shall provide the following control and communication inputs as standard:

a) An Ethernet control input. This input can support a connection to a Strand ShowNet system, and shall be supplied Advanced Network Control (ACN) ready. Each Ethernet control input can generate Reporting messages for the dimmer rack. This input shall also allow for local connection to a personal computer, providing setup, playback, library storage, dimming reporting features, and the ability to load rack-operating software.

b) Two optically isolated DMX512 (RS485) control inputs. The first input shall accept DMX512-RDM only. The second DMX512 input may be configured to accept DMX512-RDM, Strand Lighting's System Wide Control (SWC) dimmer protocol or Strand Lighting's Outlook architectural protocol. SWC allows sophisticated and independent remote control of circuits and presets through an optional hand held Personal Digital Assistant (PDA) programmer (via an optional wireless network) and/or preset stations. Outlook is a control system comprised of architectural style panels for recording and playback of presets in individual assigned "rooms". Each input shall have a patch to allow overlapping or separate control operations. Optically isolated contact inputs, for external switching interfaces (24V 100ma). These closures are dedicated for:

    PANIC ON Momentary Turns Panic On
    PANIC OFF Momentary Turns Panic Off
    FIRE ALARM Maintained Turns Panic On, no Override
    SWC PRESET 1 Momentary Fires SWC Preset 1
    GO NEXT SWC Momentary Fires "next" SWC Preset
    GO SWC OFF Momentary Fires SWC Preset 0 (Blackout)

c) There shall be two optically isolated contact closure outputs, for connection to a dimmer rack beacon indicator in the rack face. The first channel (green) will be held on when the rack is in normal operation with no errors reported in the dimmer rack. The first channel shall turn off, and the second channel (Red) will flash when there are errors reported in the dimmer rack.

d) An A/V Serial Interface port shall be provided. This input shall support connection to an external A/V or show control system that supports an RS232 or RS485 serial connection. A command protocol of SWC PRESET XXX GO (SWCXXX$) with a return command of SWC PRESET XXX EXECUTED (PREXXX$) shall be supported. Serial connection shall be configurable for the Baud Rate, Parity, Stop, and Data Bits.

1.6 Rack Electronics, Features

1.6.1 The rack electronics shall provide two levels of operator interface.

a) A local standard interface that includes 6 menu keys and a bitmapped backlit LCD display (minimum 16 character x 4 line) to access standard system menus.
b) A networked customizable Web based interface that includes status displays, configuration and maintenance utilities, integrated on-line help system, and alert emails. Support for wireless PDA's shall allow query and control functions.
c) Each RPM will be imbedded with a unique serial number and password system.

1.6.2 The dimmer control electronics shall have 16 bit (minimum) fade processing and a dimmer update rate better than 16 ms (60 Hz) or 20 ms (50 Hz). Dimmers set to the same level shall output within +/-.5V of each other, regardless of phase or input voltage, providing the desired level is less than the phase input voltage less the dimmer insertion voltage.

1.6.3 The dimmer output levels shall be regulated for incoming line voltage variations. The regulation shall adjust for both RMS voltage and frequency changes of the incoming AC wave form. Regulation shall maintain the desired output voltage +/- .5V volt for the entire operating range (90 – 264 VAC). The regulation shall compensate for variations of the AC waveform on a dimmer-by-dimmer basis. There shall be no interaction between dimmers in the system or any other equipment. The output shall be regulated to the user programmable maximum voltage level on a dimmer-by dimmer basis between 24V and 240V for dimmer modules with SCR power devices, and 12V to 240V for dimmer modules with IGBT power devices. The processor response time to incoming line changes shall take no more than 16 ms (60 Hz) or 20 ms (50 Hz). Dimming systems that do not respond to line voltage and frequency variations shall not be acceptable.

1.6.4 The control electronics shall allow the maximum output levels of individual dimmers to be adjusted, e.g. to compensate for load circuit voltage loss. The selected dimmer curve shall regulate so that the curve is proportional to the programmed maximum voltage.

1.6.5 The RPM shall also have the capability to support dimmers of different types and sizes that may be mixed throughout the rack. Individual dimmers may be dimmed or switched (non-dim). The individual phase control or switching of positive and negative line voltage half cycles shall not be acceptable, as the net resultant DC line current may damage or degrade line supply transformers.

1.6.6 As a standard, dimmer rack status reporting shall report the following conditions/data:

a) Rack input line voltage per phase.
b) DMX512 Port A input fail.
c) DMX512 Port B input fail.
d) Phase failure (A, B and C)
e) Rack temperature
f) Rack overtemp warning (37 Degrees Celsius)
g) Rack overtemp shutdown (40 Degrees Celsius)
h) Rack panic.

1.6.7 Optional Dimmer Reporting Cards (DRC) can be installed into a standard dimmer module and shall report the following conditions/data:

a) Dimmer type in slot. (Dimmer dipswitch set at factory)
b) Load (Wattage) per dimmer.
c) Deviation from recorded dimmer load.
d) No dimmer load.
e) Excess DC on dimmer.
f) Overload on dimmer.
g) Power device failure (short circuit or open circuit).
h) Circuit breaker open.
i) RCD open

j) Dimmer fault.
k) Change in dimmer type fitted.
l) RMS Phase current per rack phase
m) Dimmer module temperature (w/module shutdown on and over temperature condition.
n) Forced on at dimmer module.
o) Dimmer panic.

1.6.8 Dimmer Reporting Cards shall also provide functionality for:

a) Contact closure input. Each reporting channel shall be “forced on” to full (at the hardware level, overriding all other software control inputs) when this closure is made.
b) LED Output. Each reporting channel shall support a bicolor LED. “Green” shall be sued to track the control signal level, and “Red” shall be used to indicate a reporting fault. A reporting fault indication overrides a signal level indication.

1.6.9 The control electronics shall provide the following setup functions that shall be user programmable on a per rack or system wide basis:

a) DMX512 Port A patch.
b) DMX512 Port B patch.
c) Architectural patch for Outlook control systems.
d) Set rack and circuit ID's (CID).
e) Dimmer reporting enable/disable. (by dimmer module).
f) Record Outlook preset and preset crossfade time.
g) Record SWC preset and preset crossfade time.
h) Set dimmer level (%).
i) Set IGBT dimmer max. voltage (12V - 260V in 1V steps).
j) Set SCR dimmer max. voltage (24V - 260V in 1V steps).
k) Set dimmer min. level (0 to 99%).
l) Set dimmer curve.
m) Set dimmer response time.
n) Set control input priority logic.
o) Set status reporting parameters
p) Program user curves
q) Time Server for dimmer rack clock synchronization.

1.6.10 The DMX512 Port A and B patching shall support a rack start address and individual dimmer patch. The architectural patch shall define the rack circuit/room/room channel relationship for Outlook control systems.

1.6.11 The control electronics shall provide a facility to disable the output of any individual dimmer by setting the level to 0. It shall also be possible to enable and disable dimmer status reporting on a per dimmer basis.

1.6.12 The control electronics shall contain 128 System Wide Control (SWC) user programmable presets a permanent blackout preset (preset 0) and a user-definable power up preset. It shall be possible to record individual preset crossfade times, including preset 0. The presets shall be user programmable as a snapshot of the current dimmer outputs resulting from all dimmer control sources according to selected control logic, on a per rack or system wide basis. Each preset may have an individual crossfade time between 0 seconds and 60 minutes. The 24-hour real time clock may trigger up to 24 SWC events. Time resolution to be a minimum of one second.

1.6.13 The control electronics shall support a user assignable “control lost” SWC preset. Each rack shall, in the event of loss of control signal according to the selected port logic, maintain the last levels for a user programmable period ranging from 0 seconds to 60 minutes. After this time period it shall automatically fade to the “control lost” preset. Alternatively it shall be possible to program the rack to indefinitely hold the last dimmer levels. It shall be possible to continue control without an active control signal using any of the SWC or Outlook architectural presets. Time resolution to be a minimum of one second.

1.6.14 The control electronics shall provide an architectural Outlook control system preset capability of 8 presets plus full ON and OFF for each of 16 separate rooms with programmable fade times between 0 seconds and 4 minutes. Time resolution to be a minimum of one second.

1.6.15 The control electronics shall provide the ability to set one or a group of dimmers to any level.

1.6.16 The control electronics shall provide the ability to set a library or user programmable 100-point curve (processor to apply a linear interpolation between the user points) to any individual dimmer. Library curves shall be:

a) Square curve.
b) S-curve.
c) Linear power output curve.

1.6.17 User selectable curves shall be:

a) Non-dim (switched) with a programmable trigger level 0 - 99%.
b) Electronic ballast fluorescent curve with a kick-start voltage and user programmable top set and bottom cut-off point.
c) Magnetic ballast fluorescent curve with user programmable top set and bottom cut-off point.
d) Five user defined programmable curves, programmed with up to 100 steps. The processor is to apply a linear interpolation between the user points.

1.6.18 Each dimmer shall have one of three user programmable response (rack will fade to the new target level in the defined response time) in order to optimize lamp filament life and speed of operation:

a) Fast (30 ms).
b) Normal (100 ms).
c) Slow (300 ms).

1.6.19 The control electronics shall provide a number of user programmable control logic schemes, regulating the logical relationship between dimmer control sources It shall be possible to set the way in which various control inputs interact with each other to create priorities between all control inputs.

1.6.20 It shall be possible to load new rack operating software via the Ethernet connection to the dimmer rack. There shall be no requirement to turn power to the rack off during the loading of rack software, and in addition the Panic facility and Redundant Tracking Backup (RTB) processors shall be fully operational during software loading to the active processor. It shall be possible to load new rack operating software into the processor, regardless of the state of the program storage.

1.6.21 The Rack Processor Module default language shall be English. One optional language file may be installed on the processor during software installation/upgrades. During normal operation, a menu choice shall be provided on both the LCD and GUI interface to switch (on the fly) between the default English file and the optional language files. Pressing a (to be designated) combination of keys on the RPM front panel shall force the processor to English (on the fly). Optional language files shall be available in the following languages – Chinese, Dutch, French, German, Italian, Japanese, Portuguese, Russian, and Spanish.

1.7 Dimmer Peripheral Equipment

1.7.1 The dimmer system shall support the following range of optional specialist peripherals:

a) Wired Remote SWC backup preset button panels. The dimmer system shall support 8- and 16-preset SWC wall mounted panels with tactile keys and integral LED indicators per key. The panel shall control 8 or 16 consecutive presets stored in the dimmer racks following a user programmable start address. The panel shall enable the recording of presets, the playback of presets and the turning off of the active playback. It shall be possible to disable the panel recording function. It shall be possible to connect a total of 30 SWC panels on one SWC system. Wired preset button status LED's must update when an SWC preset is recalled locally at the processor, or via a networked PDA or PC.

b) Wireless Remote SWC hand held personal digital assistants (PDA's), accessing an SWC web page (in both PC monitor, and PDA screen formats) running over a wireless Ethernet Network. This peripheral offers dimmer control using standard control system syntax and direct action level keys, preset and preset time recording. The SWC PDA shall be functional with distributed dimming systems in conjunction with other SWC wired panels and shall not require the presence of an additional control system to function. Up to 4 SWC hand held PDA's may access the system at any time.

c) Wired or Wireless remote personal computers accessing a web page for user programming, library storage of dimmer setup data and remote monitoring of dimmer and load status. Up to 6 remote personal computers may access the system at any time.

d) Wired Remote Outlook panels for architectural style channel and preset control of separate and independent (rooms). The dimmer system shall support a range of wall mounted Outlook architectural style panels consisting of preset keys with integral LEDs, channel and master faders for setting, recording and playback of architectural style presets in individual assigned zones (rooms). Additional peripherals shall consist of panels allowing the zone (room) channels and presets to be joined and un-joined, infrared remote control for up to 8 zone (room) presets and Audio-Visual (A/V) interface units enabling 8 dimmer presets, on and off to be controlled by external contact closures. Wired preset button status LED's must update when an Outlook preset is recalled locally at the processor, or via a networked PDA or PC.

2. Dimmer Modules

2.1 General

The dimmer modules shall be designed using advanced, state-of-the-art components specifically for entertainment lighting. Dimmer modules for 230 volt applications shall be available in dual 3kW, dual 5kW, Quad 2.5kW and single 10kW thyristor modules and dual 3kW and dual 5kW Sinewave module configurations. Modules of similar types shall be interchangeable allowing systems with both standard and Sinewave dimmers to be configured freely. Systems that do not permit the mixing of standard and Sinewave dimmers shall not be accepted.

2.1.1 The dimmer modules shall be designed using advanced, state-of-the-art components. The dimmer module shall be capable of "hot patching" cold, incandescent loads up to its full rated capacity without malfunction with the control signal at full ON.

2.1.2 All single and dual dimmer modules shall be available with optional dimmer status reporting.

2.2 Physical

2.2.1 The dimmer modules shall be fully plug-in and factory wired. Dimmer modules shall be of rugged and heavy duty construction enclosed by a formed aluminum chassis. Power and signal pins shall be recessed in a self-aligning housing to avoid handling, storage, and insertion damage. A contoured handle shall be provided for ease of insertion and withdrawal. All chassis parts, except heat sinks, shall be properly treated, primed and finished in fine texture, scratch resistant, coating. Each module shall be labeled with the Strand Lighting logo and rating. Modules constructed of molded plastic for structural support shall not be acceptable. Dimmer modules shall be UL, CUL, VDE, TUV listed and CE marked devices.

2.2.2 Dimmer modules shall be keyed so that dimmer modules of greater capacity shall not be interchangeable.

2.2.3 Non-Dim modules shall be available to provide dedicated non-dim circuits not employing SSR devices. Dual modules shall be available providing non-dim/non-dim configurations. Each non-dim shall be provided with a primary circuit breaker of the appropriate rating. Non-dims shall be designed so they can be used for inductive loads.

2.2.4 Standard factory modules shall be available to provide hard fired output for use with neon, cold cathode, and fluorescent (European 3 & 4 Wire ballasts) loads.

2.2.5 Sinewave dual dimmer modules shall be available with current ratings of 3kW and 5kW (230 volts). Each module shall offer full dimmer status reporting to match all other modules in the **EC**21 range. Sinewave Dimmer modules shall be fully interchangeable with standard dimmer modules of the same current rating and may be used in systems with standard dimmers.

They shall conform to the following specification:

a) Dimmer output waveform shall be a fully symmetrical Sinewave at any output voltage setting eliminating all lamp noise and reducing reflected harmonics on the building power supply. Total Harmonic distortion shall be less than 1% and efficiency shall be 98%. Dimming shall be performed using pulse width modulation of the mains supply at 47 KHz. Systems employing forward or reverse phase control techniques or requiring 50/60Hz chokes to limit the load current rate-of-rise shall not be acceptable.
b) The dimmer module shall pass the power factor of the load back to the mains. Systems not offering this performance shall not be acceptable.
c) Each dimmer module shall offer microprocessor controlled over-current and short circuit protection and will automatically shut down in the presence of these conditions. Resetting the dimmer to zero from the control system shall restore operation in the event of a module shutdown.
d) The dimmer shall control a wide range of loads including dimmable electronic ballasts, LED's, motors and conventional incandescent lamps in a manner similar to a conventional autotransformer. No audible noise shall be generated with the use of Sinewave dimmer modules.

2.3 Electrical

2.3.1 Each dimmer module shall contain circuit breakers, associated solid state switching modules, filters, power and control components.

2.3.2 Standard dimmer electronics shall be completely solid state. They shall utilize two silicon controlled rectifiers in a back-to-back electrical configuration or four. The full load of the circuit is to be carried and controlled by the silicon controlled rectifiers.

2.3.3 Each 230 volt dimmer shall be protected by a range of optional circuit breakers including single pole (SP) Single pole neutral disconnect (SPN) and RCD type thermal magnetic circuit breakers of the appropriate current rating mounted on the face plate of the dimmer module. The circuit breaker shall be rated for tungsten loads having an inrush rating of no less than 20 times normal current and shall disconnect the power to the dimmer module before damage can be done to the dimmer power components. The circuit breakers shall be rated for 100 percent switching duty applications and shall be VDE, TUV listed and CE marked devices. Quad dimmer modules shall be available with SP breakers only.

2.4 Dimmer Module Power Devices

2.4.1 Thyristor power devices shall be encapsulated, epoxy filled high impact plastic cases with optically isolated firing circuits, control circuitry, and two silicon controlled rectifiers (SSR's). There shall be a minimum of 2,500 (4,000 in 50Hz systems) volts RMS of isolation between the AC line and the control lines of the thyristor. The thyristor shall be in an industry standard format that is easily field replaceable without removing any other electrical or electronic devices.

2.4.2 IGBT power devices (for Sinewave modules) shall be encapsulated epoxy filled units with integral heatsink and thermal sensor. IGBT gate drive shall be optically isolated and shall provide be a minimum of 2,500 (4,000 in 50Hz systems) volts RMS of isolation between the AC line and the terminals of the IGBTs.

2.5 Thyristor Power Device Filtering

2.5.1 Each Thyristor power device dimmer module shall have an integral inductive filter to reduce the rate of current rise time resulting from the thyristor switching on. The filter shall limit objectionable harmonics, reduce lamp filament sing and limit the radio frequency interference on line and load conductors.

2.5.2 Standard Rise dimmers shall have a rise time of not less than 200 microseconds measured at 90 degrees conduction angle from 10% to 90% of output wave form with dimmer operating at maximum load. Voltage rate of rise (slew rate) must not exceed 420 millivolts per microsecond in any point of the wave under full load conditions.

2.5.3 Hi-Rise dimmers shall have a rise time of not less than 400 microseconds measured at 90 degrees conduction angle from 10% to 90% of output wave form with dimmer operating at maximum load. Voltage rate of rise (slew rate) must not exceed 210 millivolts per microsecond in any point of the wave under full load conditions.

3. Approved Manufacturer and Products

3.1 Dimmer Racks, Dimmer Modules, Control Electronics.

3.1.1 Dimmer racks, modules and control electronics shall be Strand Lighting **EC**21 series.