

CLIP-LV

Current Limiting Protector Catalog

750V; 4000A Continuous; 200kA Fault Interrupt

G&W



▲ G&W headquarters in Bolingbrook, IL USA

COMPANY PROFILE

Since 1905, G&W Electric has helped energize the world with innovative power system solutions. With the introduction of the first disconnecting cable terminating device, G&W began to build a reputation for engineering custom solutions to meet the needs of system designers. Solutions which today have extended far beyond cable accessory products and into the latest in load and fault interrupting switchgear, reclosers, system protection equipment and distribution automation.

HEADQUARTERS

G&W headquarters is located in Bolingbrook, IL, USA, a suburb of Chicago. G&W also has manufacturing facilities or sales offices in China, Mexico, Canada, Dubai, India, Singapore and Brazil. G&W covers the globe with product installations and sales representation in over 100 countries and all seven continents.



G&W Electric Facilities:

G&W Electric Co. Headquarters
(Bolingbrook, IL, USA)

G&W China (Shanghai)

G&W Canada
(Brampton, Ontario)

G&W Mexico (San Luis Potosi)

G&W do Brasil (Salvador)

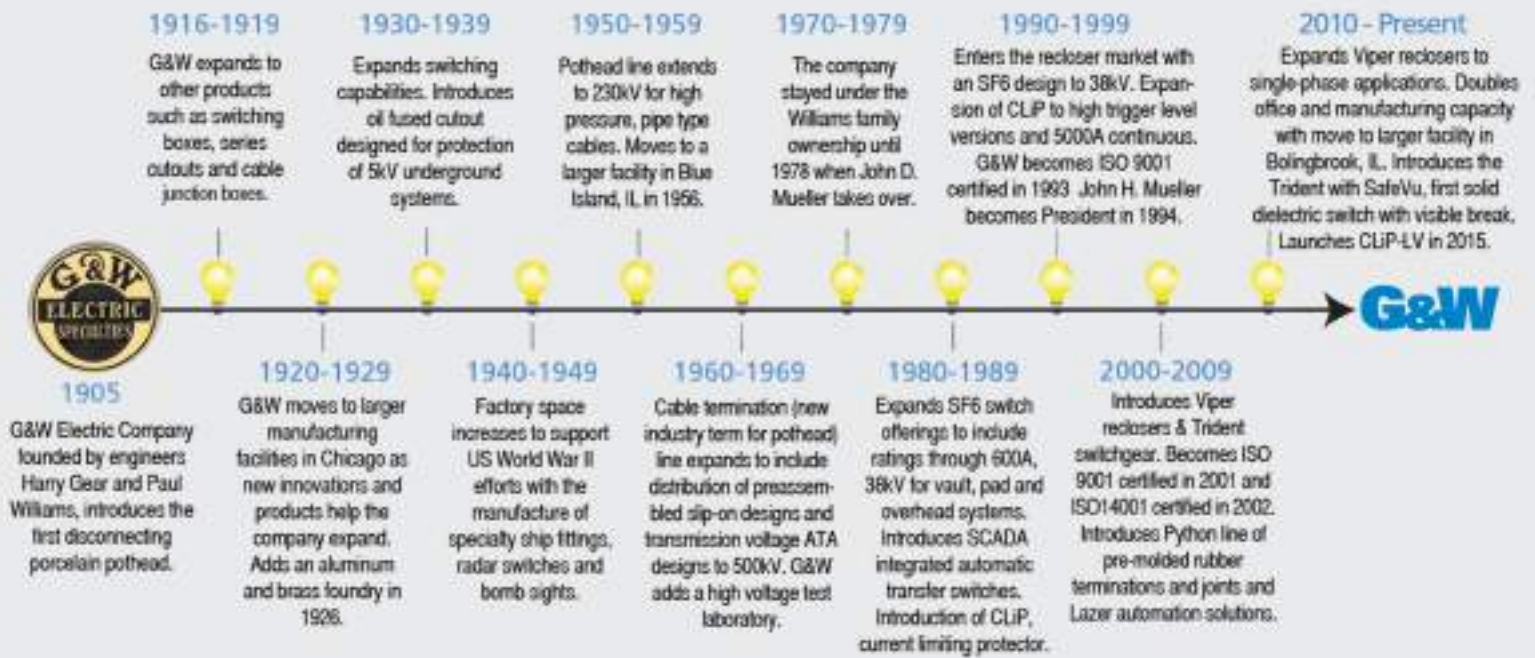
G&W sales office (Dubai)

G&W sales office (Delhi, India)

G&W sales office (Singapore)

Manufacturer's Brass and Aluminum Foundry
(Blue Island, IL, USA)

OVER 110 YEARS SERVING OUR MARKETS



G&W PRODUCT OVERVIEW



Single and Three Phase Solid Dielectric Reclosers



Solid Dielectric Underground Distribution Switchgear



SF6 Underground Distribution Switchgear



System Automation and Smart Grid Solutions



System Protection Equipment



Transmission and Distribution Cable Accessories

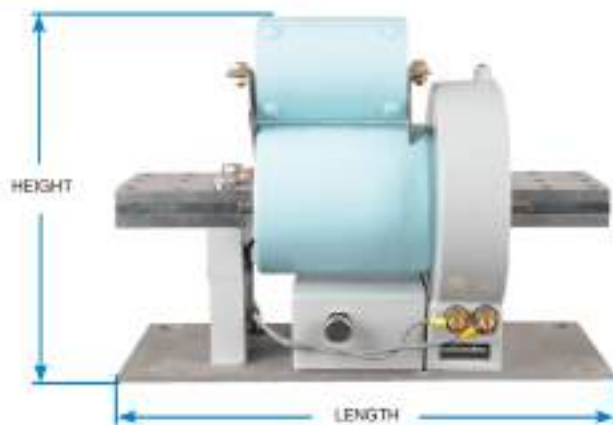
FEATURES AND BENEFITS

Features	Benefits
Single phase & three phase protection	Use the hi-speed remote indication relay contacts (located in the control box) to trip a breaker and interrupt unfaulted phases. No need to replace interrupters in unfaulted phases.
Threshold current sensing (Does not use transient susceptible rate of rise current sensing)	Hardened transient filtering responds to actual current values, not transients or harmonics.
	Can directly protect capacitor banks and harmonic filters.
	Consistent peak let-thru values, regardless of fault asymmetry level.
Field-selectable trigger levels (pick-up)	Adjust trigger levels in the field to ensure continuing protection as the site characteristics change.
Remote enable/disable	If protection is temporarily not required it can be remotely disabled. It then acts simply as a busbar. The operation modes are PLC and SCADA adaptable.
Remote trip indication	Three-phase remote indication of operation (within 3 cycles) provides two Form C contacts for remote monitoring and trip of user's series breaker to prevent single-phasing.
Outdoor duty	Can be installed outdoors without an enclosure.
No fuse aging associated with transients or inrushes	No need to replace aging fuses, providing substantial long-term cost savings.
Copper busbar	Lower system losses, resulting in improved reliability. Lower peak let-through, resulting in better current limiting performance.

ELECTRICAL RATINGS

Voltage class	750V
Continuous current (rms, sym)	Up to 4,000A*
Interrupting rating (rms, sym)	Up to 200kA*
Available trip levels	Up to 42kA* instantaneous
Clearing time	Interrupt between 1/4 - 1/2 cycle in accordance with UL-248-1 and IEC 60269
Input voltage requirements	24 - 250V AC/DC; 150W peak, 60W nominal

*Contact your local G&W sales representative for alternate ratings.



Single or Three Phase	Dimensions (mm)	Weight* (kg)	Maximum Voltage & Current	Interrupting Rating	Catalog Number
Single phase	18.5" L x 9.7" W x 13.1" H (470mm) x (245mm) x (330mm)	85 lbs (39 kg)	750V; 4000A	50kA	1-CLiP-750-4000-50
				100kA	1-CLiP-750-4000-100
				200kA	1-CLiP-750-4000-200
Three phase	18.5" L x 27.7" W x 13.1" H (470mm) x (703mm) x (338mm)	255 lbs (102 kg)	750V; 4000A	50kA	3-CLiP-750-4000-50
				100kA	3-CLiP-750-4000-100
				200kA	3-CLiP-750-4000-200

*All weights are approximate

OPTIONAL EQUIPMENT:

- The Field Test unit provides means of verifying proper operation of the CLiP-LV installation. It pulses a fault-level current through the main bus resulting in a triggering response that is measured for the proper characteristics.
- Powder coated IP32, or NEMA 3R enclosures.
- DC to AC inverter can convert D.C. voltage to A.C. as required for the CLiP-LV Controls.
- Remote Triggering Capability by Arc Flash Relays or other means.



▲ Field Test unit mounted on CLiP-LV

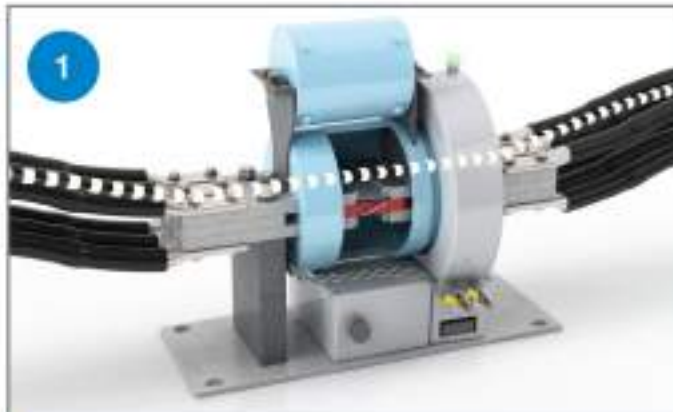
ADDITIONAL NOTES:

- A standard three-phase unit comes complete with interrupters, mounting system using stainless steel channel base, sensing and firing logics, and tinned copper bus with pad for customer connection.
- Units are suitable for either 50 or 60hz applications. Contact your local G&W Sales Representative for additional frequencies.
- IP66, NEMA Type 4X, welded steel, powder-coated Remote Control Box is included. This contains terminal blocks for user's power supply, control voltage monitor relay with two N.O. and 2 N.C. (form C) contacts and enable/disable relay.
- All hardware is stainless steel, brass or silicon bronze.
- The CLiP-LV can be installed in any orientation. Control cables are of submersible construction.
- The control box can be adapted to any AC or DC control voltage supply. A 150W supply with nominal load of 60-80W is required.

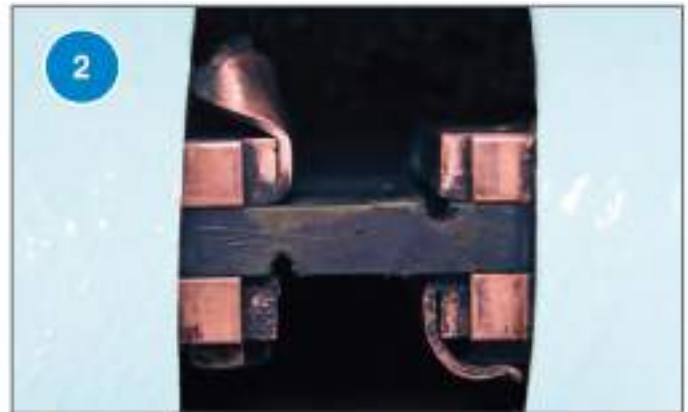
OPERATION

During normal operation, continuous current flows through a series of copper conductors. Upon occurrence of a short-circuit current, a sensing unit actuates a linear cutting device that segments the copper conductors. This action bends the copper conductors upward resulting in a gap and an arc forms at the gap.

The resultant arc voltage across the gaps redirects the short-circuit current through a small, parallel current-limiting fuse. The fuse melts and opens the circuit, as would a traditional current-limiting fuse. Current extinction occurs within the first quarter to half-cycle (prior to first peak). Reliable interruption is assured without venting of ionized gases.



▲ A copper conductor carries current through the device from the supply side to the load side.



▲ Copper conductor is severed and folded back on itself opening a gap in the conduction path. Interruption is self-contained.



▲ The resultant arc voltage across this gap causes a transfer of the short-circuit current to a small, parallel current-limiting fuse.



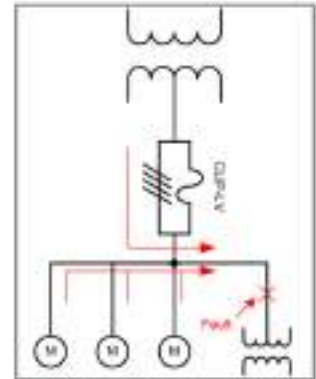
▲ The fuse melts and clears the circuit, as would a conventional current-limiting fuse. Current extinction occurs in the first half cycle, and limitation prior to the first peak.

To view the video of how the CLIP-LV operates visit: CLIP-LV.com

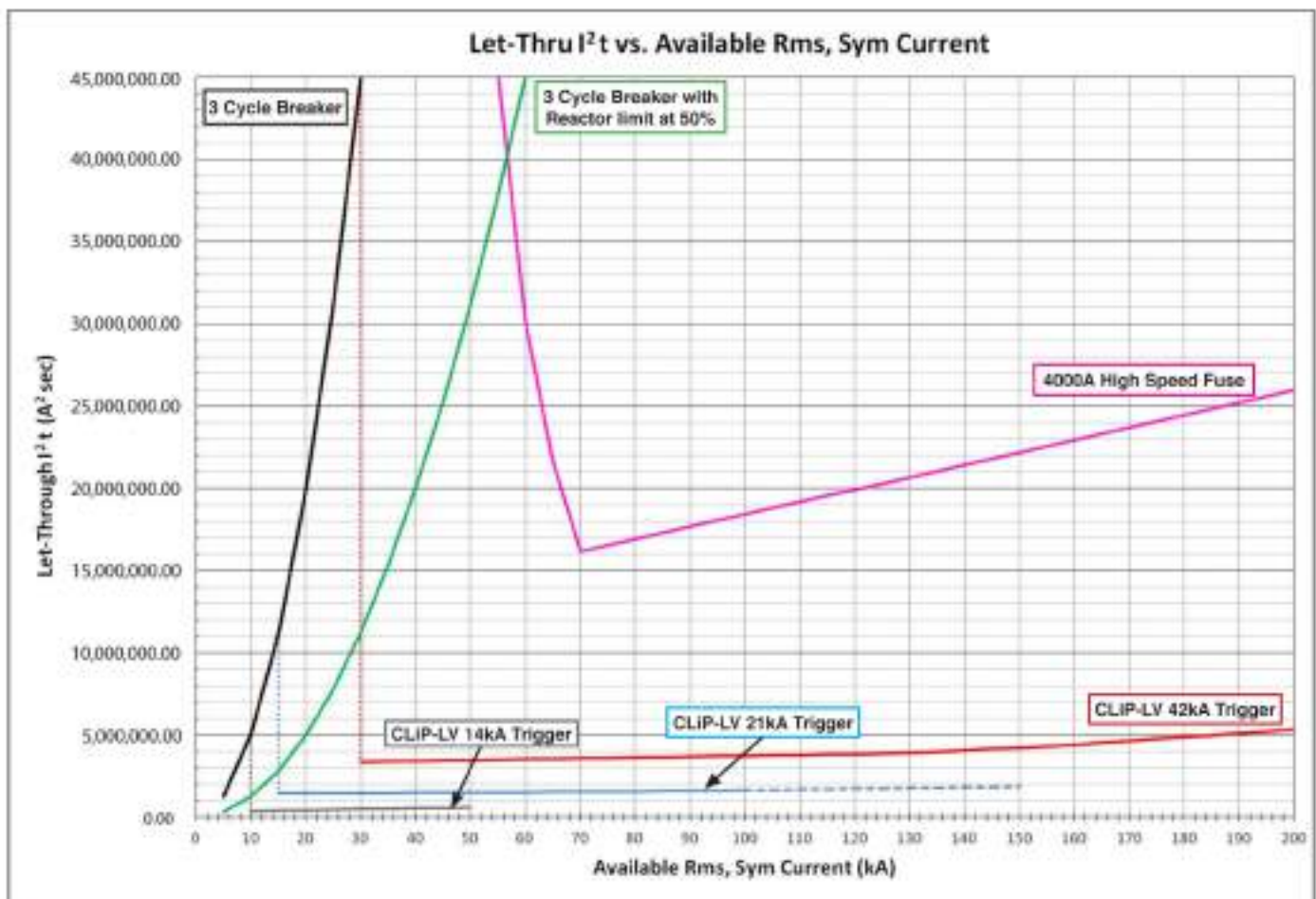
Personnel Protection, Reduce Arc Flash Exposure

An arc flash typically occurs when fault current travels through air from one conductor to another or to ground. The energy generated by the flash can cause significant equipment damage and/or serious injury. There are several mitigation methods. For personnel protection, Personal Protective Equipment (PPE) is often used, but the best method is to minimize or eliminate the problem altogether, by using the CLiP-LV to reduce the fault current and time duration.

The CLiP-LV reduces the potential arc flash severity by interrupting the circuit before the first peak current. This reduces the arcing fault duration to a sub-cycle time-frame and effectively extinguishes the arc well before alternative protection devices even begin to operate. The CLiP-LV not only mitigates the arc flash but also reduces the concussive arc blast associated with an arc flash event. The CLiP-LV does not vent the molten metal through a chute, but instead absorbs the arc energy by melting the parallel current-limiting fuse. A typical one-line diagram is shown to the right. The CLiP-LV can also be installed on each of the feeders to further provide increased protection and reliability by not removing the source transformer from service.



▲ Typical arc flash application. The CLiP-LV will interrupt the source contribution, which is typically most the total fault current.



▲ Differences between various protection techniques.

DESIGN GUIDE

Personnel Protection, Reduce Arc Flash Exposure

For arc flash mitigation the criteria may be a targeted Personal Protective Equipment (PPE) level. It is common to reduce exposure down a few levels from that encountered without the CLiP-LV, and in some cases to level "0". For these cases, the trigger level is critical, since the maximum exposure is typically at a current level just beneath that of the CLiP-LV trigger or instantaneous pick-up level. This can be readily noted on the chart on the bottom of the previous page, where the dashed vertical lines are indicative of the rms, symmetrical current level beneath which the CLiP-LV will not operate, thus permitting the breaker or similar device to clear the fault.

Follow the steps below when selecting the appropriate CLiP-LV ratings and trigger level for an arc flash or personnel protection application:

Step 1 – Determine the maximum amount of fault current flowing through the CLiP-LV that will need to be interrupted. This may or may not be the total amount of fault current on the system. Select the next highest interrupt rating from the CLiP-LV Interrupt Ratings and corresponding standard instantaneous trigger levels. For example, if the system has 60 kA rms, sym available but only 40 kA rms, sym will flow through the CLiP-LV (to be interrupted by the CLiP-LV), the proper interrupt rating would be the 50 kA rms, sym.

CLiP-LV interrupt ratings and corresponding standard instantaneous trigger levels						
Interrupt Rating (kA, RMS, SYM)	Standard Available Instantaneous Trigger Levels (units)					
50	4	6	8	10	12	14
	6	9	12	15		
100	6	9	12	15	18	21
150	12	18	24	30	36	42
200	12	18	24	30	36	42

Step 2 – Calculate the maximum worst-case inrush of downstream motors or transformers by determining the maximum total KVA simultaneously energized. This can either be the highest KVA of a single motor/transformer or it can be a sum of individual motors/transformers within this KVA grouping. Calculate the total full-load current (FLA) for motors and then for transformers that makes up the maximum simultaneously energized KVA. For motors multiply the FLA by 15 and for transformers multiply the FLA by 30 for conservative results. Add those two FLA's (one for total motor and one for total transformer) together.

Step 3 - Based on the sum of those FLA's, select a standard trigger level in the Trigger Level selection table that is just greater than the maximum expected inrush value. If a standard trigger level is not desirable, a custom trigger level can be set, please contact your local G&W Sales Representative for custom trigger level settings. If the expected inrush exceeds the maximum trigger level for the selected interrupt rating, then select the next highest interrupt rating that has a trigger level above the expected maximum inrush.

Step 4 – The worst-case condition occurs when the fault current is just below the CLiP-LV's trigger level. Below this level the circuit-breaker or similar device is expected to clear and the CLiP will not trigger. To determine the associated rms, symmetrical fault current, divide the CLiP instantaneous trigger level by 1.414 or $\sqrt{2}$. This rms, symmetrical value can be applied by the user in their arc flash analysis programs as a worst-case fault current let-thru. Please note a lesser magnitude rms, sym fault current offset by asymmetry could still operate the CLiP-LV.

DESIGN CONSIDERATIONS

- Be sure to take into account the worst-case inrush currents through the CLiP-LV.
- Select a higher interrupt rating no higher than needed for the application.
- Implement the worst-case arc flash condition just below the CLiP-LV's trigger level in an arc flash software package.

Protect Overdutied Equipment

When the available fault current increases due to the addition of co-generation, the higher fault current can exceed the withstand ratings of the existing equipment and in the event of a fault, severe damage can occur. Upgrading entire facilities is often cost prohibitive. The CLiP-LV can be used to eliminate the need to replace underrated equipment. The CLiP-LV will interrupt the fault current passing through it before the first peak current is reached, significantly reducing the peak let-thru current and interrupting duty to a value within the ratings of the equipment.

DESIGN GUIDE

Protect Overdutied Equipment

For the overdutied equipment protection application, there is a specific, maximum current target. It is the fault rating of the switchgear lineup or other equipment that the CLiP is intending to protect. This relates to the momentary and interrupting capability of the protected gear, and is reflected in the selection of the trigger level for the current limiter. It is recommended that you contact your local G&W Sales Representative to ensure a correct trigger level choice.

Step 1 – Determine the maximum amount of short-circuit current available on the system and determine the amount of short-circuit flowing through the CLiP-LV in both directions (i.e. for a fault on one side of the CLiP-LV and on the other side of the CLiP-LV). This is the amount of current the CLiP-LV is required to interrupt.

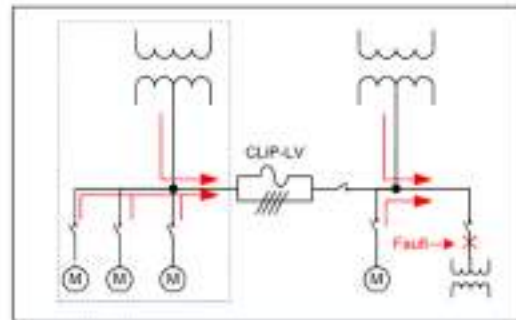
Step 2 – Determine the maximum allowable rms, sym current through the CLiP-LV before an operation is required to protect the system. This value may be different for the left bus of the CLiP compared to the right bus. Once the maximum allowable rms, sym short-circuit current is determined, multiply the rms, sym current value by $\sqrt{2}$ or 1.414 to get the equivalent instantaneous current which is used to select the CLiP-LV's trigger level.

Step 3 - Repeat steps 1 and 2 for all operating scenarios that require the CLiP-LV to operate and protect the system. These operating scenarios are typically any scenario where the system's breaker interrupt ratings and peak withstand ratings are exceeded, due to variations in how the system is operated (open switches, different source transformers, loading, etc.). If there are any operating scenarios where the CLiP-LV's protection is not needed, the CLiP-LV can be remotely disabled via its control box. The CLiP-LV will then act as busbar in the system and will not operate. The CLiP-LV must be enabled a minimum of 3 seconds before its protection is required to allow the electronics to charge up.

Step 4 – Take the lowest trigger level calculated in Step 2 for all operating scenarios and select a standard trigger level just below the calculated value. A table of available trigger levels is given on page 9. If desired, G&W can provide a 1st cycle graphical plot showing the CLiP-LV's performance in any given system. This can provide reassurance the proper trigger level is selected and the system is fully protected under all operating conditions.

DESIGN CONSIDERATIONS

- The CLiP-LV is electronically sensed and triggered. As a result, one can accurately portray the CLiP-LV wave in time, where its point of peak let-thru is typically quite early, and not near the crest of those other currents on the system. See chart on page 12. In other words, the CLiP-LV peak let-thru is not added directly at the asymmetrical crest of other currents, as is commonly done in the evaluation of traditional, meltable fuses. For this reason, no peak let-thru curves are not provided.
- The traditional calculation means of simply adding the fuse let-thru to the crest of those other currents is commonly inappropriate for triggered limiters, and may result in the sum being shown as substantially higher, and possibly exceeding the switchgear peak capability when that may not be the case. For this reason, it is highly recommended that users intending to apply the CLiP for peak limitation purposes should contact G&W for a no-cost analysis of CLiP peak let-thru conditions in combination with other currents that are not interrupted by the CLiP.
- Avoid energizing a no-load or light-loaded bus through the CLiP-LV
- Be sure to factor in capacitor bank inrushes/discharges through the CLiP-LV. Especially back to back switching of capacitor banks through the CLiP-LV.

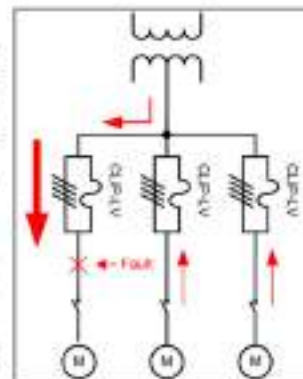


▲ Typical bus tie application. For a fault on the right bus, the CLiP-LV will interrupt feeder to the right on the left bus (inside the dashed line). For a fault on the left bus, the CLiP-LV will interrupt all fault sources.

Minimize Damage

Even if equipment is rated properly to withstand the available fault duty, the let-thru energy of a fault may still result in costly damage. Traditional equipment such as relays, circuit breakers and current-limiting reactors are far less effective at preventing this from occurring. At lower continuous currents, current-limiting fuses prevent this damage. At higher continuous currents the CLiP-LV provides effective current-limiting performance of a much lower rated fuse, but with electronically controlled operation.

Selection of trigger levels (pick-up) for minimizing damage is more subjective. Normal, non-fault current levels that must flow through the CLiP-LV should be considered. This may be the instantaneous peak of a motor or transformer inrush, or instantaneous peak fault level of equipment reflected to the opposite side of the transformer where the CLiP-LV resides. Let-thru I^2t value, peak current let-thru value or similar criteria may also be targeted. Unlike overdutied equipment applications, in cases where there is not a distinct peak let-thru (cutoff) current value required for the CLiP-LV, a minimum trigger level which avoids response to typical expected inrushes should be considered.



▲ Typical minimizing damage application. Note, only the CLiP closest to the fault will operate. All other CLiP-LVs will not operate.

DESIGN GUIDE

Minimize Damage

Follow the following steps when selecting the appropriate CLiP-LV ratings and trigger level for damage limitation application:

Step 1 – Determine the maximum amount of fault current flowing through the CLiP-LV that the CLiP-LV will interrupt. This may or may not be the total amount of fault current on the system. Select the next highest interrupt rating from Trigger Level Table on page 9. For example, if the system has 60 kA rms, sym available but only 40 kA rms, sym will flow through the CLiP-LV (to be interrupted by the CLiP-LV), the proper interrupt rating would be the 50 kA rms, sym.

Step 2 – Calculate the maximum worst-case inrush of downstream motors or transformers by determining the maximum total KVA simultaneously energized. This can either be the highest KVA of a single motor/transformer or it can be a sum of individual motors/transformers within this KVA grouping. Calculate the total full-load current (FLA) for motors and then for transformers that makes up the maximum simultaneously energized KVA. For motors multiply the FLA by 15 and for transformers multiply the FLA by 30 for conservative results. Add those two FLA's (one for total motor and one for total transformer) together.

Step 3 - Based on the sum of those FLA's, select a standard trigger level in the Trigger Level selection table that is just greater than the maximum expected inrush value. If a standard trigger level is not desirable, a custom trigger level can be set, please contact your local G&W Sales Representative for custom trigger level settings. If the expected inrush exceeds the maximum trigger level for the selected interrupt rating, then select the next highest interrupt rating that has a trigger level above the expected maximum inrush. The determination of the trigger level is dependent on what level the circuit-breaker is expected to operate versus the level that the CLiP-LV is expected to operate.

Step 4 – The worst-case condition occurs when the fault current is just below the CLiP-LV's trigger level. Below this level the circuit-breaker or similar device is expected to clear and the CLiP-LV will not trigger. To determine the associated rms, symmetrical fault current, divide the CLiP-LV instantaneous trigger level by 1.414 or $\sqrt{2}$. This rms, symmetrical value can be applied by the user to calculate the let-thru I^2t , which is commonly used as a measure of damage assessment, similar to let-thru energy. This is calculated using the square of the value above, times the operating time of the breaker in seconds (usually between .033 and .083s), depending on the combined relay plus breaker speed. Please note a lesser magnitude rms, sym fault current offset by asymmetry could still operate the CLiP-LV.

DESIGN CONSIDERATIONS

- Be sure to take into account the worst-case inrush currents through the CLiP-LV.
- Select a higher interrupt rating no higher than needed for the application.
- Implement the worst-case arc flash condition just below the CLiP-LV's trigger level in an arc flash software package.

TRADITIONAL DEVICES

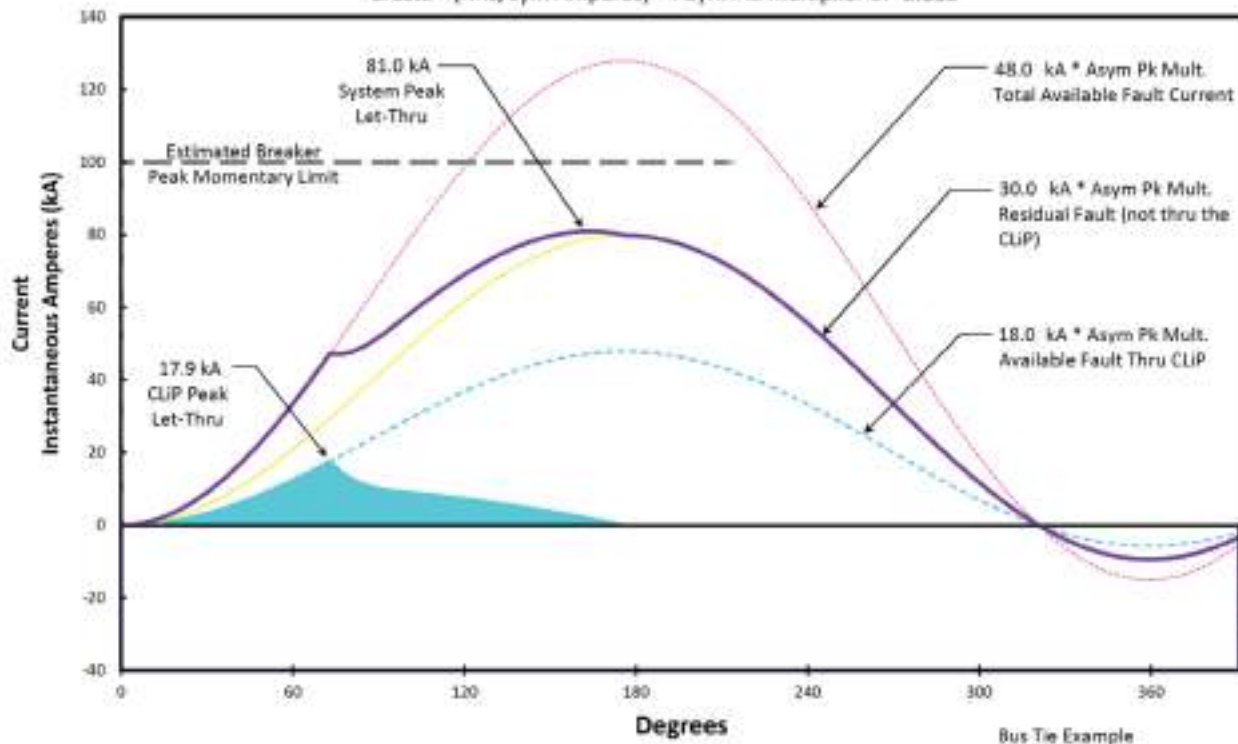
		Design Considerations
Conventional Fault-Interrupting Devices	Current-limiting Fuse	<ul style="list-style-type: none"> • Reduced current-limiting capabilities at low-level fault currents • Motor starts, lightning surges and heavy transients may damage traditional fuse elements or change their response, requiring replacement • No status feedback available
	Expulsion Fuse	<ul style="list-style-type: none"> • Emits blasts when clearing faults and ineffective in limiting let-thru energy • Lower-level fault currents may partially melt the fuse, resulting in failure or limited performance if not known or replaced • No status feedback available
	Circuit Breaker	<ul style="list-style-type: none"> • Much slower clearing times allow for far greater energy let-thru and requires maintenance • Requires an external device (relay) to send the operational signal which delays the circuit interruption
Conventional Current-Limiting Devices	Current-limiting Reactor	<ul style="list-style-type: none"> • Large size often does not fit in retrofit applications • Adds to system losses (internal resistance in mohm range) during normal operation • Blocks VARS transfer out of generators • No status feedback available
	Three-phase Earthing Switch	<ul style="list-style-type: none"> • Large size often does not fit in retrofit applications • Eliminates the arc by inducing a bolted fault on the system, which adds stresses to the entire electrical system • Equipment lifespan may be reduced

CLiP® Asymmetrical Fault Interrupt

Projected for 14 kA instantaneous trigger level

Circuit X/R of 25.00 is applied

Crests = (rms, sym Amperes) * Asym Pk. Multiplier of 2.662



This checksheet pertains to the CLiP-LV overcurrent protection device, generically referred to as an Is-Limiter. It is applied for the purpose of current limiting circuit protection. The following information is required to provide a quote for the appropriate CLiP-LV unit and to select the appropriate trigger level.

The Application is for (check all that apply):

- Arc Flash Mitigation Minimize Damage Overduty Equipment Protection
 Generator Limitation Bus Tie Closure Feeder Protection

Comments on the application: _____

System Characteristics:

Voltage _____ Continuous Current _____ Frequency _____

External Control Power _____ Volts AC DC

Remote Triggering Option Yes No

Maximum available short-circuit current
in RMS Symmetrical Amperes at nominal
voltage to the fault (worst case) _____

Maximum available short-circuit current
in RMS Symmetrical Amperes at nominal
voltage through the CLiP-LV _____

Interrupt rating of protected equipment
in RMS Symmetrical Amperes (breaker rating) _____

Momentary (peak) rating of protected equipment
in RMS Symmetrical Amperes _____

Peak inrush values from:

Transformers _____ Motors/Generators _____ Capacitor Banks _____

**If possible provide a One-Line Diagram of the system and short-circuit simulation study.
Model the CLiP-LV as both an open and closed switch in the short-circuit study.**

Environmental:

- Location: Indoor Outdoor
 Mounting Orientation: Horizontal Vertical Inverted Other
 Enclosure: No Yes, provided by other Yes, provided by G&W

Ambient Temperature: Max. _____ °C Min. - _____ °C
(if < -40 or > +40°C)

Altitude (if over 1000m) _____ meters

Air-borne Corrosives? (describe) _____

G&W Electric's Current Limiting Protector product line is a result of a series of Electric Power Research Institute (EPRI) and U.S. Department of Energy projects in the late 1970's. EPRI is a consortium of the research branches of numerous utilities in the United States, with common needs and common project development goals. In essence, the original medium voltage CLiP was specified by U.S. utilities and designed to their requirements.

EPRI had two specific requirements that needed to be met for this project, outdoor applications and elimination of rate-of-rise (di/dt) current sensing. Extensive field-testing was conducted as part of the development phase, on Boston Edison and Consolidated Edison utility systems. G&W marketed this initial EPRI device while developing a second generation unit.

The first G&W production units were installed in 1985, starting G&W's 30 years of design, manufacturing and application experience with Current Limiting Protectors. The product line has continued to grow with distinct improvements in the sensing circuitry, transient hardening, isolation transformer design, controls design and customer interface improvements. By 1987, a medium voltage CLiP had successfully cleared over 300kA rms, symmetrical fault at 15.7kV on a power test laboratory system.

The medium voltage CLiP has been successfully installed in both industrial and utility applications.

1. Industrial applications most commonly involve bus tie interruption, switchgear lineup protection, cogeneration limitation, reactor bypass and individual feeder protection of pieces of critical equipment.
2. Universities and hospitals are also substantial users of these devices. Their generators can cause utility substations to become overdutied from their back feed on a utility fault.
3. Utilities apply medium voltage CLiPs in protection of auxiliary systems of generating plants, sometimes on generators themselves, in substations and rather extensively in underground network protection of large cities.



▲ CLiP protecting a methane fueled co-generators in a sewage treatment plant.



Users include:

- Refineries
- Generating stations
- Shipboard & oil platforms
- Wind & solar installations
- Chemical plants
- Cement plants
- Paper mills
- Capacitor bank and harmonic filter banks
- Steel mills
- Mining and smelting

◀ A substation CLiP protecting a government facility.

The medium voltage CLiP has been proven to reduce Arc Flash and Arc Blast, minimize damage, and protect overdutied equipment in over 40 countries on 6 continents.

CLiP - Current Limiting Protector

- 2.8 to 38kV, continuous current to 5000A
- Arc flash and arc blast reduction
- Network protection
- SCADA adaptable
- Indoor/outdoor application
- Faster system restoration



CLiP-LV

- 750V, 4000A continuous
- 200kA interrupt rating
- Arc flash and arc blast reduction
- Secondary network protection
- Faster system restoration



High Current Limiter

- 2.8 to 38 kV, continuous current to 50A, interrupting to 120kA sym, BIL impulse to 200kV
- Often used for tertiary winding protection



Power Assisted Fuse

- 2.8 to 38kV, continuous current to 600A, interrupting to 60kA sym, BIL impulse to 200kV
- Capacitor bank and harmonic filter protection



G&W offers Technical Support and Services:



Custom Engineering

Our engineers can tailor our products to meet the needs of any application.



Custom Programming

Our automation engineers can provide tailored relay programs to meet any specified needs.



Factory Acceptance Testing

G&W's Factory Acceptance Testing ensures customers' automation solutions are certified to operate properly and meet all requirements prior to being installed in the field.



Training Services

G&W offers a range of training solutions at both G&W facilities and on site.



24 Hour Technical Support

Technical support for G&W products is available 24 hours a day, 7 days a week.



Engineered to order. Built to last.



DIVISIÓN DE EQUIPOS E INFRAESTRUCTURA PARA SERVICIOS DE ENERGÍA ELÉCTRICA

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