

# Upgrading Power Systems by Replacing CO-Series Electromechanical Relays with Startco Feeder Protection

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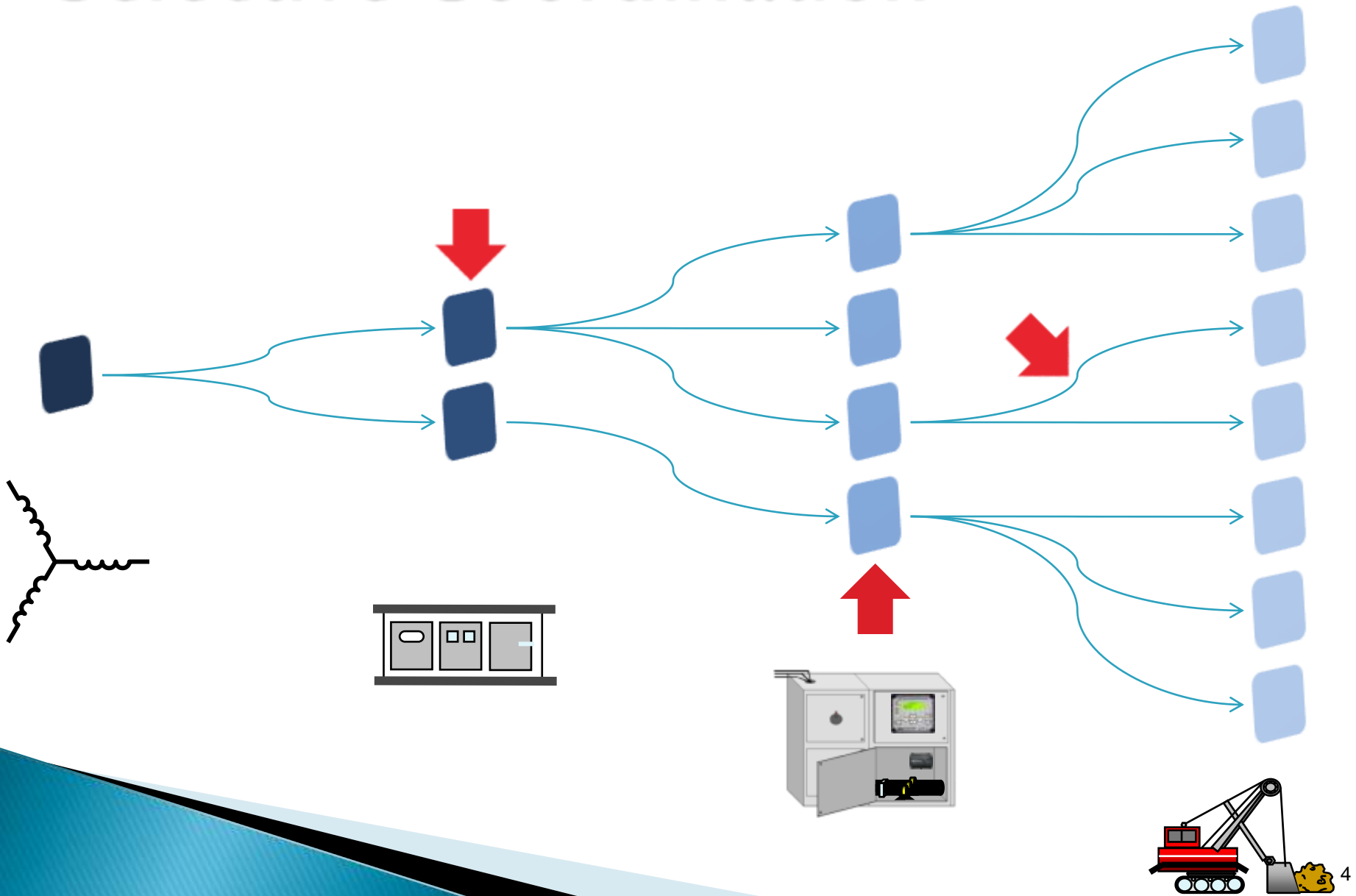
# Agenda

- ▶ Selective Coordination
- ▶ Time–Current Curves
- ▶ CO–Series Overcurrent Relays
- ▶ Startco FPU–32 Feeder Protection Unit
- ▶ Why Upgrade?
- ▶ Summary
- ▶ Questions

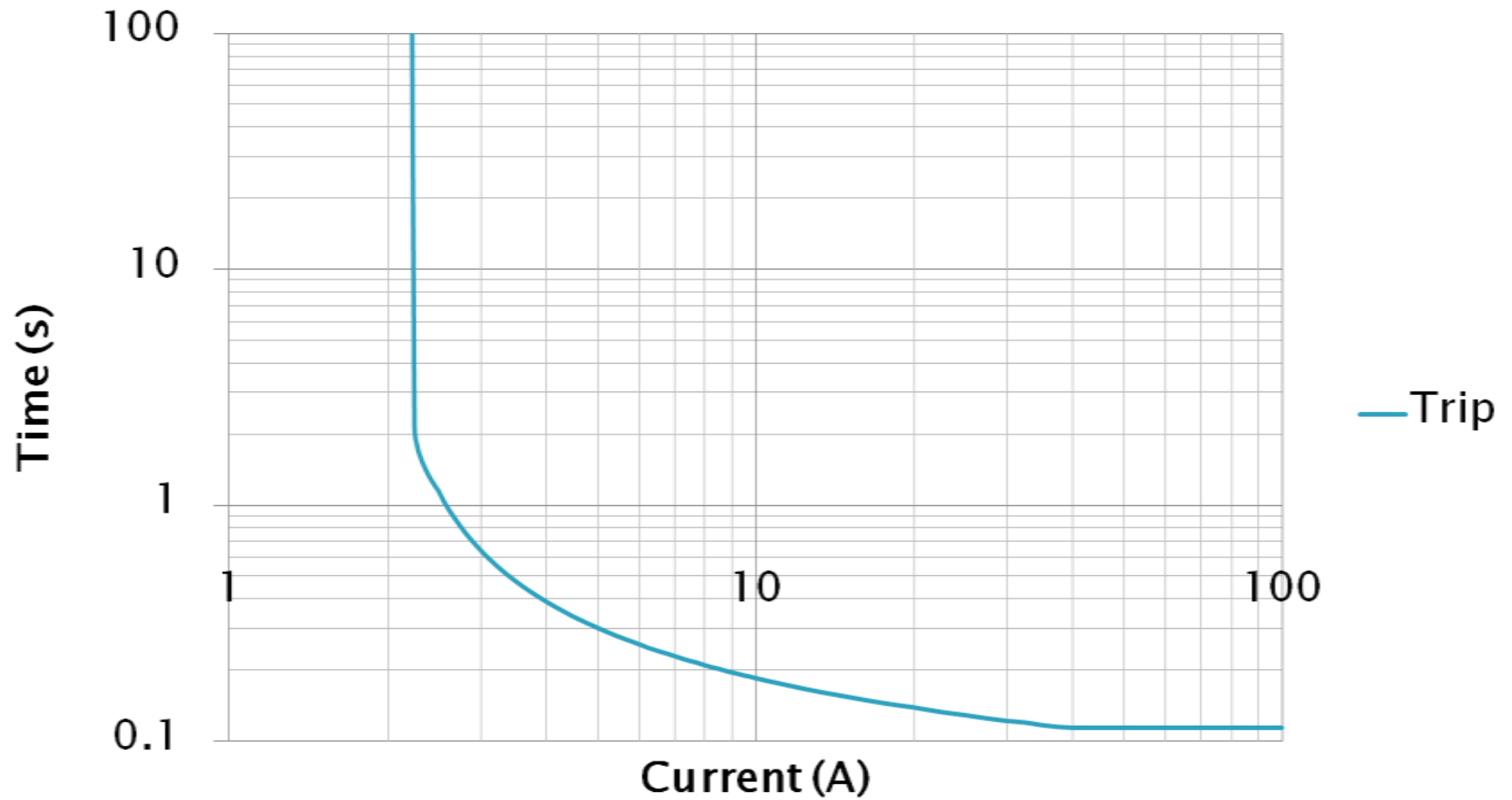
# Selective Coordination

- ▶ Is achieved with the disconnection of the individual load or feeder, affected by an electrical fault, allowing the remainder of the system to function.

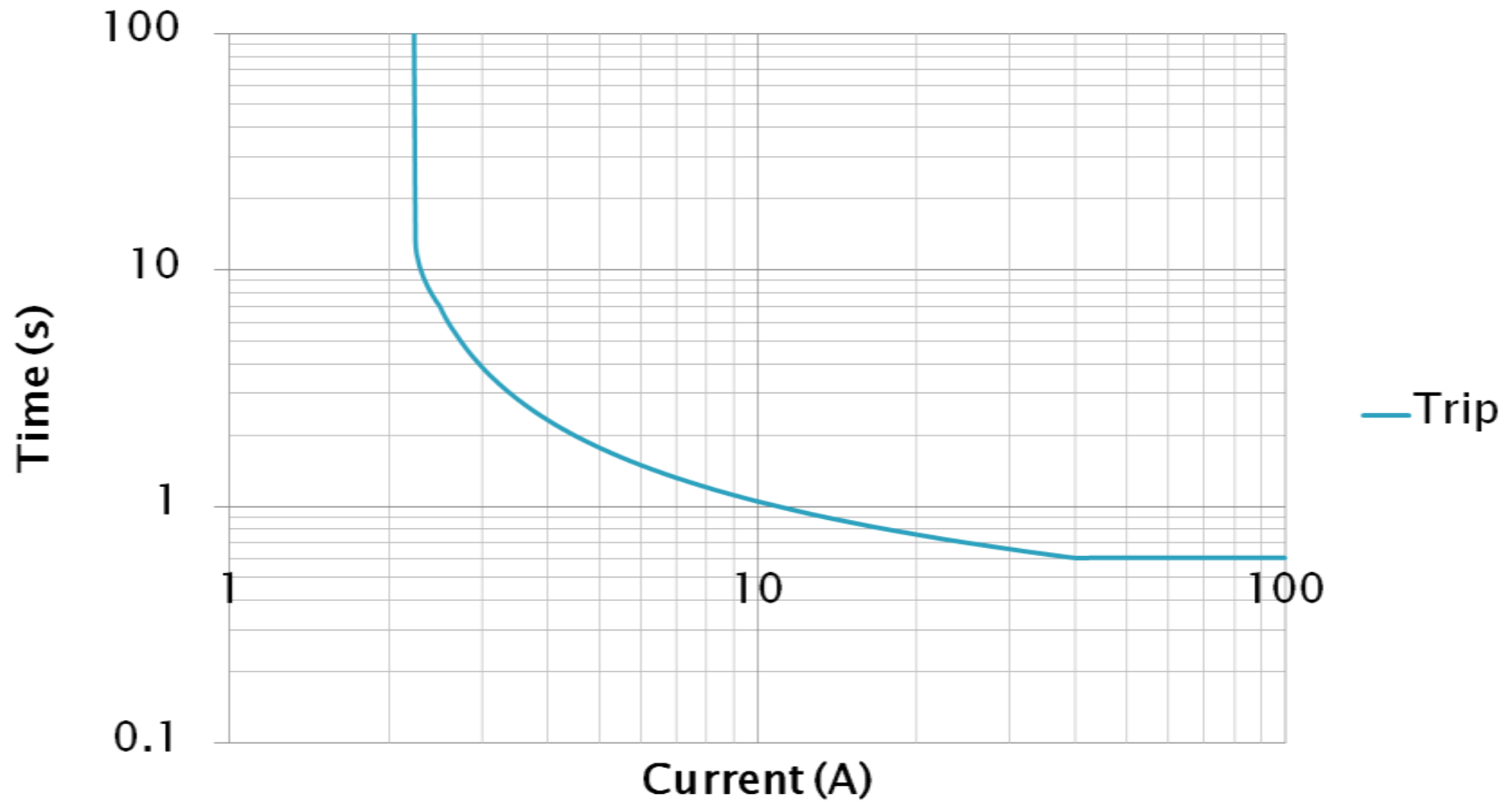
# Selective Coordination



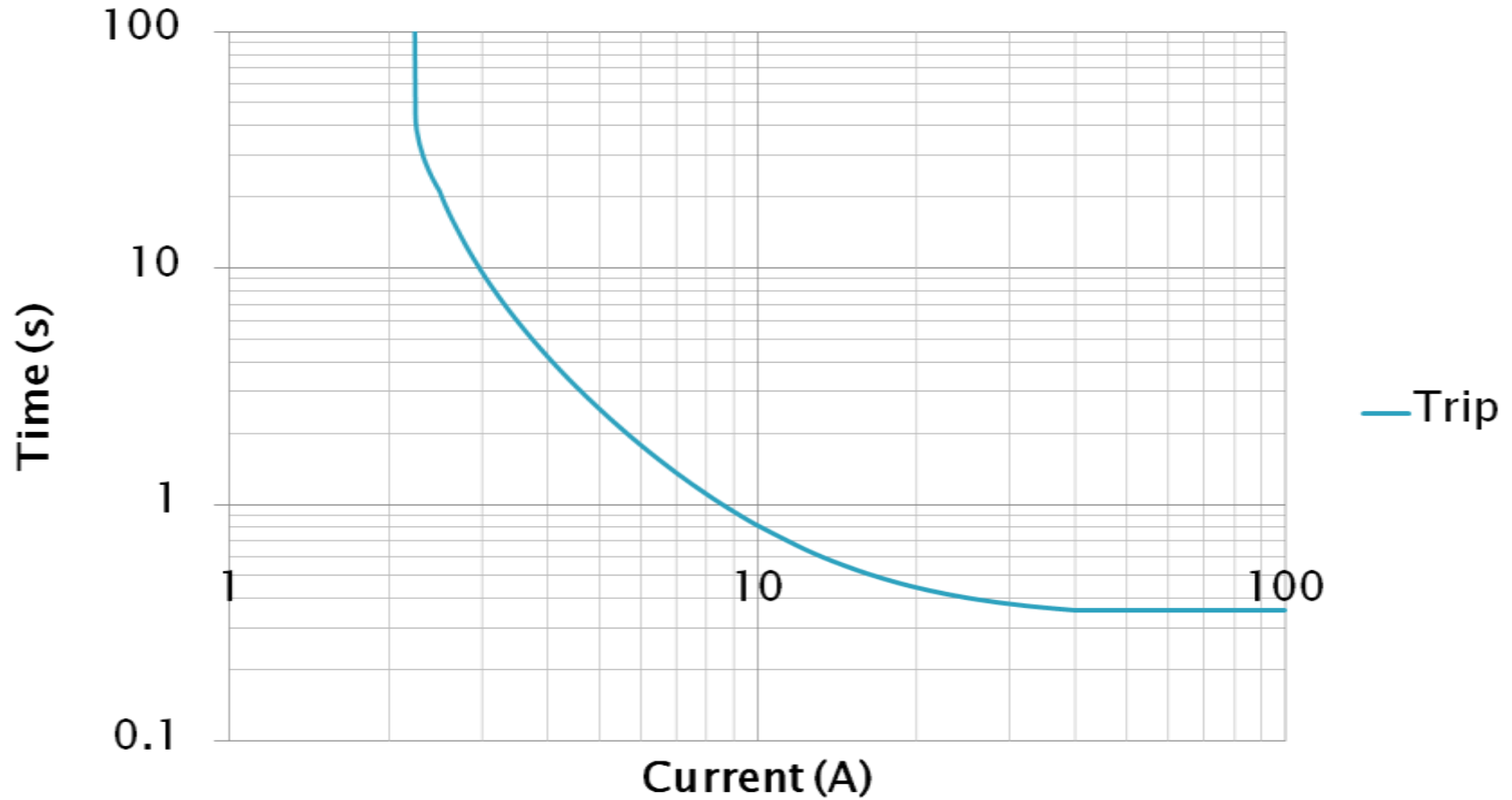
# Time-Current Curve



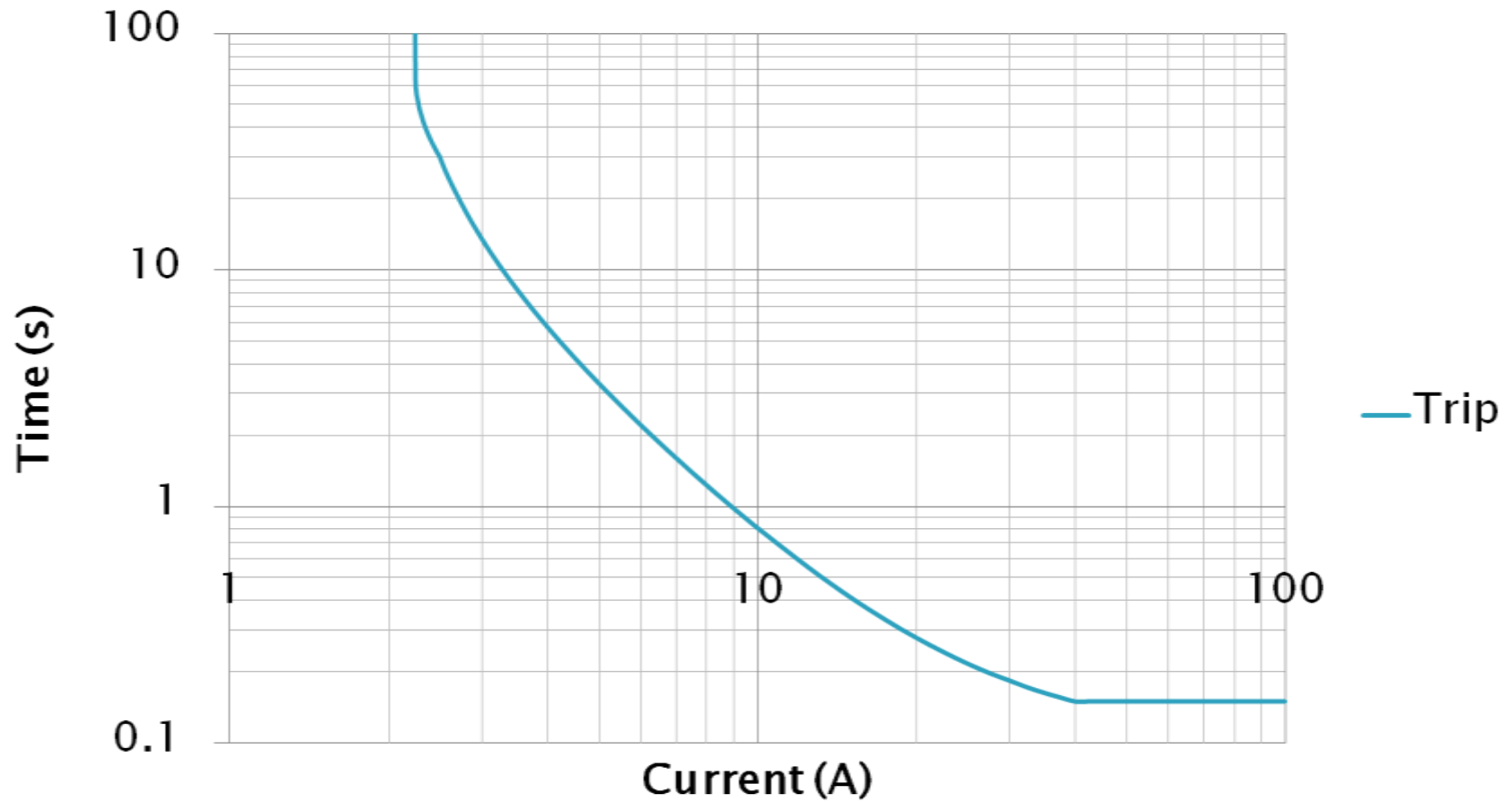
# IEEE Moderate Inverse: CO-7



# IEEE Very Inverse: CO-9



# IEEE Extreme Inverse: CO-11





## CO-7 Hi-Lo Overcurrent Relay

The CO-Series look very similar to one another.

# CO-Series Overcurrent Relays

- ▶ The CO-Series relay is an electromechanical device designed to energize in the event of a phase or ground fault. It does so by employing the magnetic field generated by fault current to force the closure of a contact. For selective-coordination purposes, eight individual relays were designed to function according to specific time-current characteristics.

# CO-2 (Short)

- ▶ Differential protection of bus or generators where restraint windings are not required. Straight overcurrent protection where short operating time is necessary for system stability.

# CO-4 (Long [Step])

- ▶ Designed primarily to provide effective relay coordination with the selective trip characteristics of down-stream breakers. Step-time operating characteristic coordinates with selective trip curve of down-stream breaker and associated fuses.

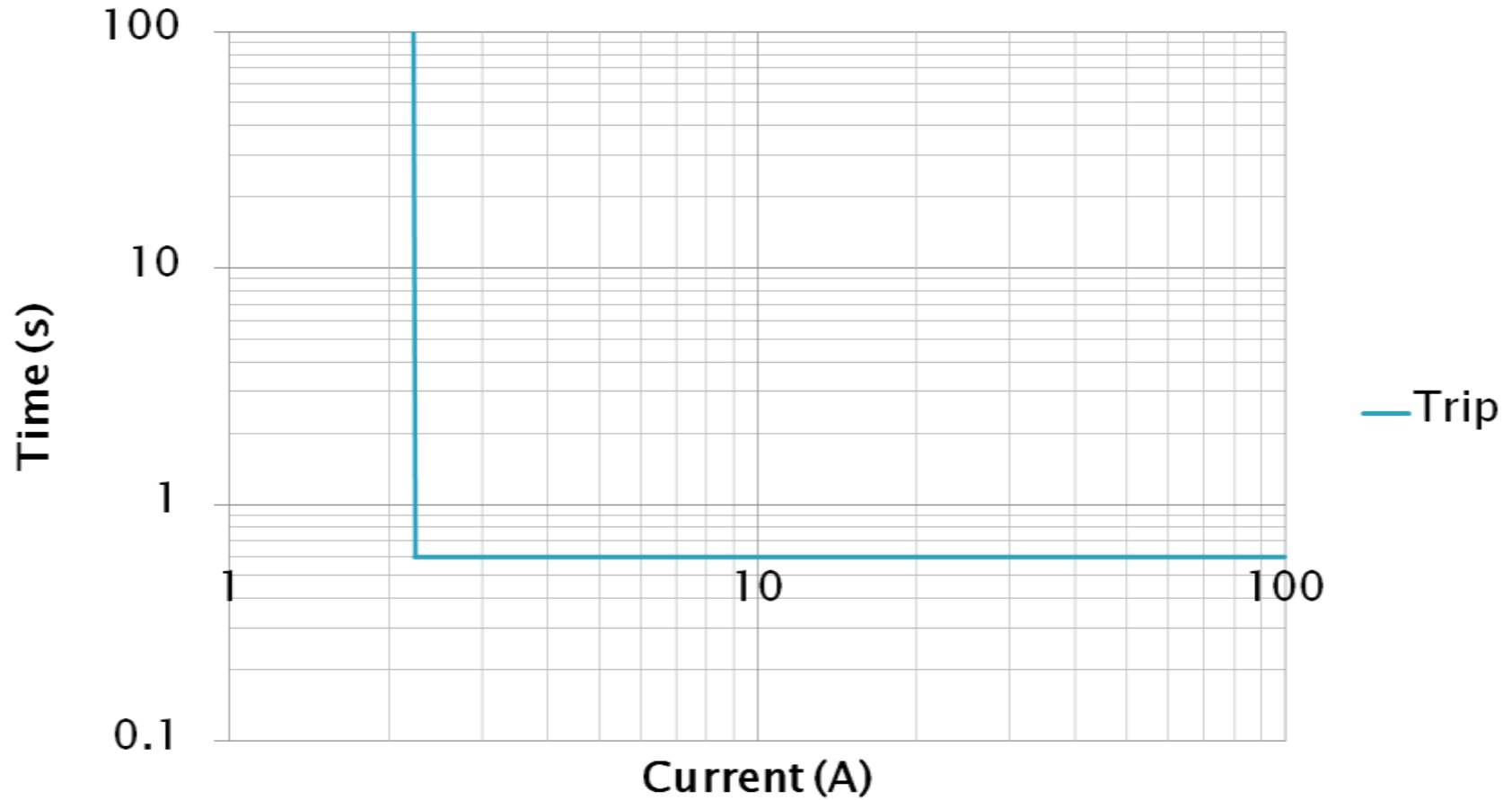
# CO-5 (Long)

- ▶ Motor protection, Long time setting (150% of full load) prevents tripping due to motor starting currents, and allows motor to carry moderate overloads for safe periods. Inverse characteristic provides faster tripping at higher overloads.

# CO-6 (Definite)

- ▶ For use where generating capacity and fault currents vary over a wide range. Relay has fixed operating time (per time dial setting) from approximately 10 to 20 times tap current, thus providing definite selective operation for sequential tripping.

# Definite Time: CO-6



# CO-7 (Moderately Inverse)

- ▶ Overcurrent phase and/or ground-fault detection on transmission or feeder lines where moderate changes in generating capacity occur, or on parallel lines where one line may be called on to carry both loads.
- ▶ Relay approaches definite-time characteristics at high currents, allowing wide changes in fault-current magnitude with little change in operating time.

# CO-8 (Inverse) & CO-9 (Very Inverse)

- ▶ Phase and/or ground-fault detection of subtransmission lines or feeders. Also supplied as primary protection or backup for other relays. Wide range in time lever settings and slope of curves facilitate coordination and assure selective operation. Degree of inverseness required is determined by fault-current magnitude, operating time desired, and the characteristics of nearby relays on the system.

# CO-1 1 (Extremely Inverse)

- ▶ Used on feeder circuit breakers which must coordinate with main and branch-line sectionalizing fuses. Also used where long-time delay is required for light overload, such as where feeder is energized after extended outage.

# FPU-32 Feeder Protection Unit



# FPU-32 Feeder Protection Unit

- ▶ The Startco FPU-32 is a feeder protection relay that provides integrated protection, metering, and data-logging functions. The FPU-32 can be programmed using the front-panel operator interface, the TIA-232 port, or an optional communications network.
- ▶ IEC and IEEE inverse-time curves are supported for selective-coordination purposes.

# Protection

- ▶ Overload (49, 51)
- ▶ Definite-time overcurrent (50, 51)
- ▶ Inverse-time overcurrent (50, 51, IEC and IEEE)
- ▶ Definite-time earth fault (50G/N, 51G/N)
- ▶ Inverse-time earth fault (50G/N, 51G/N, IEC and IEEE)
- ▶ Unbalance (46)
- ▶ Phase loss (46)
- ▶ Phase reverse (46)
- ▶ PTC overtemperature (49)
- ▶ RTD temperature (49)
- ▶ Two set-point groups

# Metering

- ▶ Line currents
- ▶ Current unbalance
- ▶ Positive-sequence current ( $I_1$ )
- ▶ Negative-sequence current ( $I_2$ )
- ▶ Zero-sequence current ( $3I_0$ , calculated)
- ▶ Earth-leakage current (CT input)
- ▶ Used thermal capacity
- ▶ Thermal trend
- ▶ RTD temperature

# Data Logging

- ▶ One-hundred records
  - Date and time of event
  - Event type
  - Cause of trip
  - Line currents
  - Current unbalance
  - Earth-leakage current
  - Used thermal capacity
  - RTD temperature
- ▶ Trip counters
- ▶ Running hours

# Why Upgrade?

## ▶ Accuracy

- An electromechanical relay's set point will drift from its calibrated value over time. A microprocessor-based relay will never require calibration.
- A cumulative set-point-drift error could cause coordination issues.

# Why Upgrade?

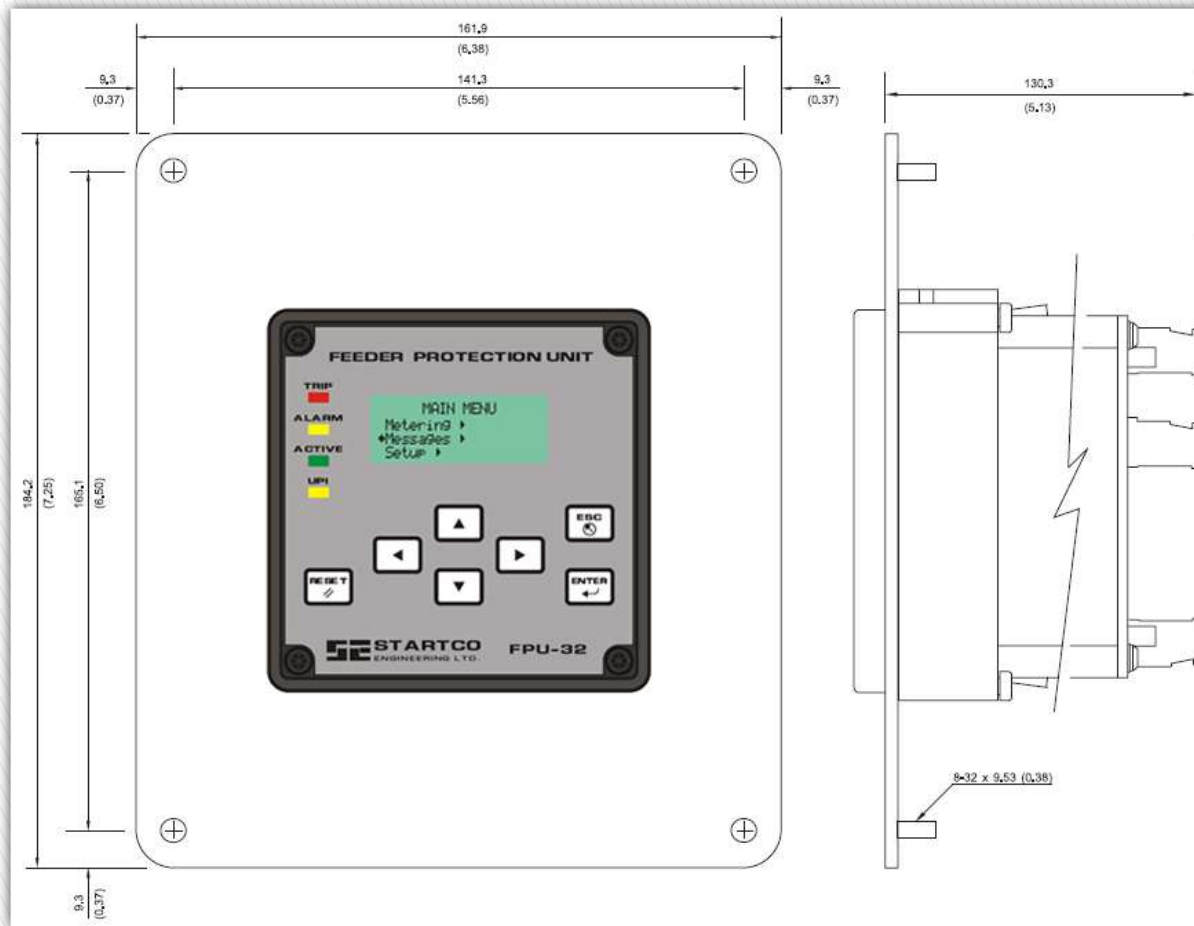
## ▶ Cost

- Annual calibration costs are eliminated.
- One FPU-32 can replace several CO-Series relays.
- The FPU-32 can utilize the existing current transformers.
- Down time is reduced.
  - Sections of the system may be removed unnecessarily.
  - Locating the fault could prove difficult if the wrong relay is tripping.

# Why Upgrade?

## ▶ Compact size

- The FPU-32 features a ¼ DIN housing.
  - Its standard size facilitates installation for brand-new applications.
  - Its small size allows the FPU-32 to replace virtually any of its predecessors.



## GE & Westinghouse Adapter Plate

Startco's custom-manufacturing department designs many such plates for varying applications.

# Why Upgrade?

## ▶ Features

### ◦ Thermal Model

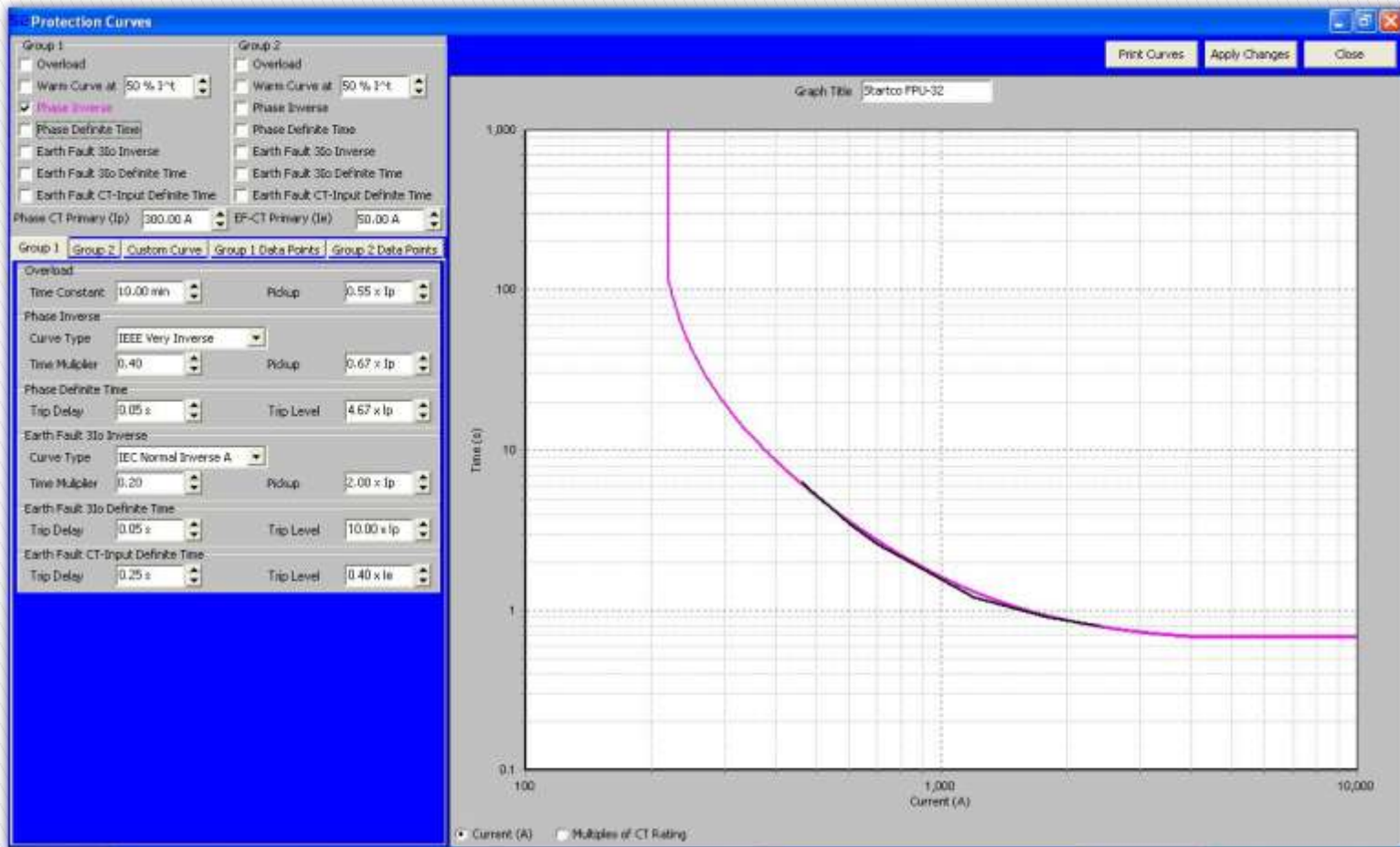
- Unlike IEC and IEEE inverse-time overcurrent protection, the  $I^2t$  protection tracks thermal capacity for currents below the pickup setting.
- The FPU-32 provides indication of thermal trend and used thermal capacity. For currents greater than or equal to the pickup current, the time-to-trip is displayed.

# Why Upgrade?

## ▶ Features

### ◦ Password Protection

- Once the results of a coordination study have been implemented, changing a relay's trip setting could adversely affect the desired results. When password access is active, all set points are locked from changes until the four-character password is entered. If set-point access is locked, the user is prompted to enter the password.



## SE-Comm-RIS Relay Interface Software

This freely available application can be used to match the operational curve of the FPU-32 to the unit it's replacing.

# Why Upgrade?

## ▶ Features

- Conformal Coating
  - Each circuit board is concealed within a conformal coating to preserve the electronics in humid, corrosive environments.
- 72-Hour Heat-Room Test
- Limited Lifetime Warranty
  - Startco feeder-protection relays (FPU-32, MPU-CIM, and MPU-CTI) are covered by a limited lifetime warranty.

# Why Upgrade?

## ▶ Features

- Extra protective functions
- Additional programmable contacts
- Two set–point groups
- Communications
- Universal power supply
- Single temperature–sensor input
- Eighty–character display
  - Programming
  - Metering
  - Data logging



## Operator Interface

The FPU-32 has a very intuitive menu structure.



## Engineering Support

Mr. Selkirk is happy to provide over-the-telephone support regarding installation, programming, etc.

# Why Upgrade?



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# Summary

- ▶ There are many benefits one can expect when replacing their CO-Series Overcurrent Relay with an FPU-32 Feeder Protection Unit.
  - Increased accuracy
  - Reduced overall cost
  - Compact size
  - Many additional protective features and functions
  - Rugged design
  - Engineering support

# Thank You!

Can we answer any of your questions?