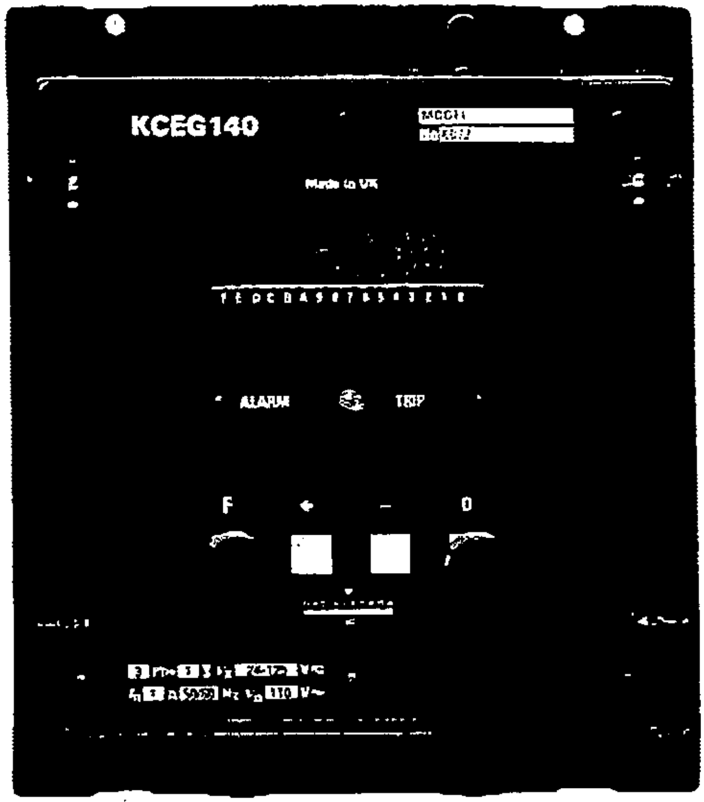
Type KCEG

Directional Overcurrent Relay for Phase and Ground Fault Protection



FEATURES

Communications & Data Storage

- Fault recording & oscillography
- Instrumentation
- Local/Remote communications
- Circuit breaker duty monitor and Circuit breaker control

User Flexibility

- Programmable inputs and outputs
- User selectable time overcurrent curves
- One time overcurrent, two instantaneous elements per phase, one undercurrent element and one undervoltage element
- Wide setting range
- Two user defined setting groups cover normal and abnormal system operations

Additional Inbuilt Protection Functions

- Breaker fail protection
- Bus protection
- Cold Load Start protection

Physical Packaging and Power Requirements

- Compact housing ideal for retrofit applications
- Aux powered (AC or DC) and self powered models
- User friendly interface

Relay Application

KCEG is used in applications where time graded directional overcurrent and ground fault protection is required. Field selection of seven inverse time characteristics and two definite time characteristics allows simplified coordination and modifications for future changes.

Features such as Breaker Failure Backup, Bus protection and Cold Load Start enhance the security and reliability of the system.

Relaying Functions

Overcurrent Function

KCEG provides one time overcurrent (I >), one low set instantaneous (I >>) and one high set instantaneous (I >>>) element for each phase function. Separate ground elements are designated $I_o >$, $I_o >>$ and $I_o >>>$ for their respective functions.

The settings for each element are separate and independently settable for phase and ground over an allowable range.

Each overcurrent element has its respective time delay designated as t >, t >> and t >>> for phase and $t_o >$, $t_o >>$ and $t_o >>>$ for ground. The timers are also independently set.

A separate undercurrent element for phase, I<, and ground $I_o <$ can be used to monitor undercurrent conditions and/or used in breaker failure applications.

Figure 1 shows the phase overcurrent elements, designated as I >, I >> and I >>>, their respective time delays, designated as t >, t >> and t >>> and the phase undercurrent element, I < and timer.

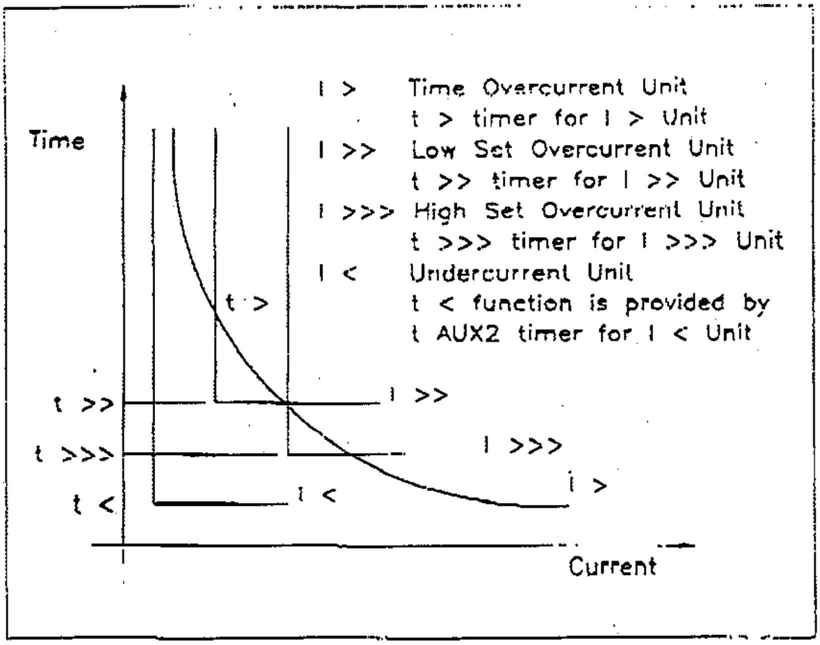


Figure 1: Overcurrent Units

Undervoltage Function

A separate three phase undervoltage characteristic can be set to provide an output when all three phase voltages fall below a set threshold, V<. An independently set timer, t_V< is used with this function.

Inputs

Three or eight programmable opto-isolated inputs are available depending on the model selected. The inputs are user defined via input masks. The inputs are programmed via menu keypad on the relay front panel or via PC with software provided with the relay.

Outputs

Four or eight programmable output relays are available depending on the model selected. The output relays are user defined via output masks. The outputs are programmed via menu keypad on the relay front panel or via PC with software provided with the relay.

In addition, a watchdog relay provides one form C contact. The watchdog circuit monitors the integrity of the relay and can indicate both healthy or failed conditions.

Logic

The configuration of the relay is accomplished in software. The setting of logic function links, along with the input and output masks, define the way the relay will operate.

This allows:

- selection of features
- implementation of user defined logic using auxiliary timers
- control of the disturbance recorder

These may be user defined via the relay front panel function keys, via PC with software provided with the relay or pre-set for you at the factory.

For setting changes, password protection is available.

Alternative Setting Group

Two sets of setting groups allow the user to set group 1 to normal operating conditions while group 2 can be set to cover abnormal operating conditions. A typical application of this feature is Cold Load Start.

When the system is de-energized for an extended period of time and then re-energized, high inrush current conditions are experienced because of motor starting and/or high load conditions such as resistance heating or air conditioning. This will trip the system unless the normal system relay settings are changed.

The Cold Load Start feature is user programmed to operate in one of two ways.

1. For applications with high resistance loads (e.g. domestic heating loads), the Cold Load Start feature automatically switches the relay settings from group 1 (set for normal conditions) to group 2 (set for cold load start conditions). This logic uses two independent settable timers. The first timer (tAUX2) controls the time delay for automatically switching to setting group 2 and is started when the system de-energizes.

   The Cold Load Start timer (tCLS) controls the time that the group 2 settings are active and is started when the circuit re-energizes. After the set time, the relay automatically reverts to group 1 settings.

2. For applications where the load is predominantly air conditioning, there will be large transient currents when the blower motors start. This option automatically blocks the low set elements

(I>>) of the relay for a settable time after re-energization of the circuit.

This feature eliminates the need to manually adjust settings in a Cold Load Start condition.

Breaker Fail and Backtrip
This protection feature allows the relay to trip the upstream circuit breaker when a local breaker failure condition is detected.

This can be accomplished in one of two ways:

1. An internal timer (tBF) is started when the relay trips. When the timer times out, the logic checks the undercurrent detector, I<, for the presence of current.

   If I< is still picked up, a breaker failure condition is detected. The local relay closes its output (backtrip) contact to provide a direct trip to the upstream breaker.
   Figure 2 shows the backtrip method for a fault on Feeder 1 that should be cleared by Relay 2 and CB-B. If CB-B fails to clear the fault, the backtrip contact of Relay 2 will trip CB-A directly to clear the fault.

2. The upstream relay may be blocked by a start contact of the local relay as shown in **Figure 3**.

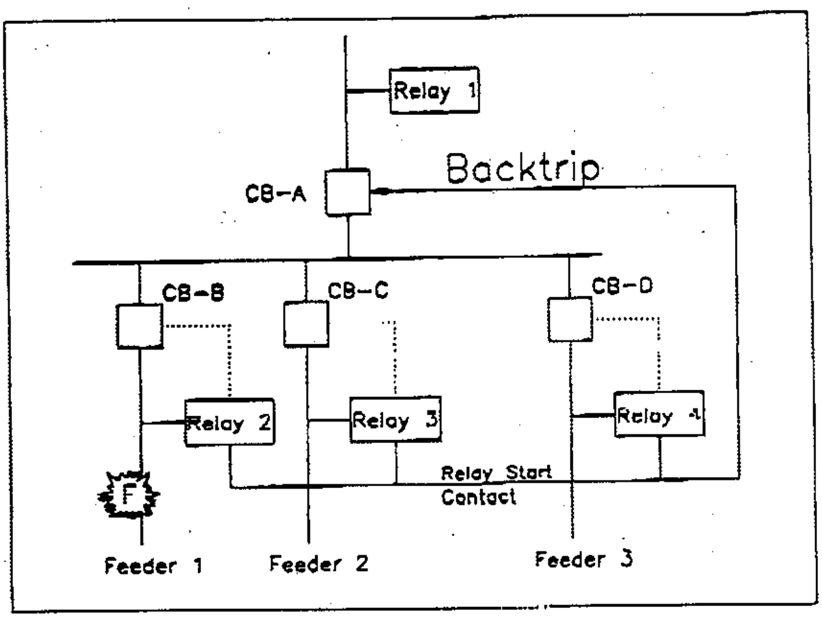


Figure 2: Backtrip Method

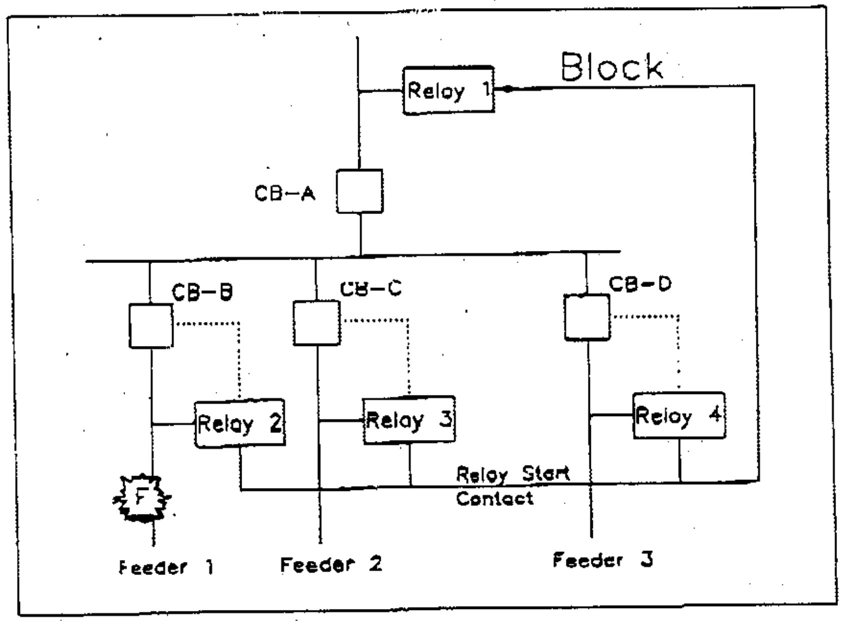


Figure 3: Blocking Method

When the local relay detects a fault, the start contact picks up to provide a block signal to the upstream relay's low set current detector, I>>. The input to the upstream relay is through an opto-isolated input.

When the local relay trips, timer tBF resets the start contact to remove the block signal. If the upstream high set current detector, I>>>, is still picked up after a settable time delay, a breaker failure condition is detected and the upstream relay trips the upstream breaker.

Figure 3 shows the blocking method for a fault on Feeder 1 that should be cleared by Relay 2 and CB-B. If CB-B fails to clear the fault, the block will be removed allowing Relay 1 to trip CB-A and clear the fault.

Bus Protection
On a radial system, KCEG can also be used for bus protection because of the relays' ability to distinguish between feeder and bus faults.

A fault on Feeder 1 is shown in **Figure 3,** The start contact of Relay 2 will send a block signal to Relay 1. When CB-B is tripped by Relay 2, the start contact resets and removes the block signal from Relay 1. The fault current will be removed before the low set overcurrent unit, I>>, of Relay 1 times out and CB-A will not trip for the successful clearing of a feeder fault.

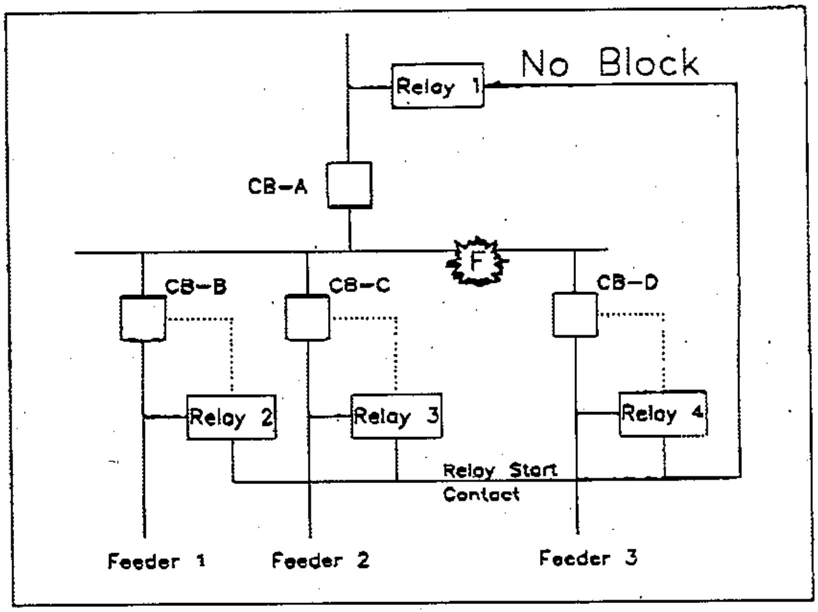


Figure 4: Bus Protection

A fault on the bus is shown in **Figure 4.** The feeder relays will not see the fault on the bus and will not send a block signal to Relay 1. Relay 1 will trip CB-A via the low set overcurrent detector, I>>, after its settable time delay, normally 50 to 60 msec.

Fault Recording and Oscillography

The inbuilt disturbance recorder measures at a rate of eight samples per cycle or 1 sample per cycle. Eight samples per cycle records sine waves while one sample per cycle records magnitude of each cycle. The disturbance recorder can store a total of 512 samples: either 64 cycles of sine wave or 512 cycles of magnitude.
The disturbance recorder has one channel allocated to each measured analog quantity, one to record the eight control inputs, one to record the eight output relays and one to record the time base.

The information in the disturbance recorder can be accessed remotely with available oscillographic software to conduct in-depth fault analysis of the events.

A sample of the oscillographic display is shown in **Figure 5.**

Fault Records

Fault targets are recorded for the last five faults The records are stored in a nonvolatile memory for local or remote retrieval.

Circuit breaker data is also stored to assist with breaker maintenance scheduling. The data includes:

- squared fault current level (I^2) on a per phase basis.
- breaker operation counter
- breaker trip time for the last fault

Events Records

Fifty events are stored in a nonvolatile buffer. The events can be downloaded to a PC with software provided with the relay. Any change of state of a control input or output relay, local setting change or operation of a protection or control function are stored in the relay with one millisecond accuracy. A setting option allows the user to save only fault records as events. This allows records for up to 50 faults to be stored.

Instrumentation

The instrumentation functions of the relay can be accessed locally or remotely and can be set as a default display on the backlit LCD of the relay front panel. The relay display eliminates the need for additional instrumentation to be mounted on the panel.

Real time instrumentation can be in either primary or secondary values, user selected, and provides:

- Phase and neutral currents
- Phase and zero sequence voltage
- Watts
- Vars
- Volt Amps
- Power Factor
- Frequency

Communications

Communications to the relay may be performed locally with the relay keypad or locally or remotely via PC.

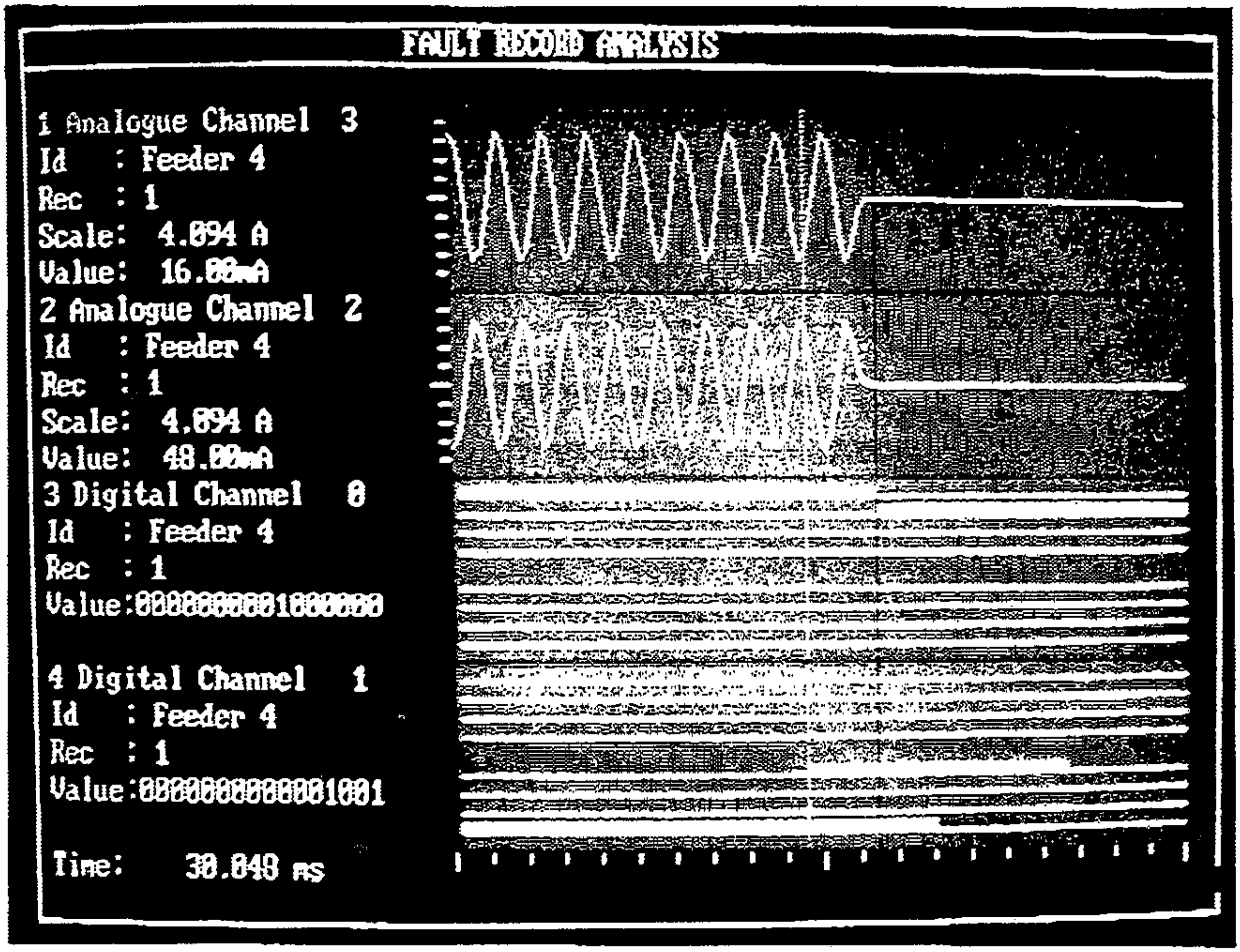


Figure 5: Oscillography, Typical Events Record

Software provided with the relay allows:

- reading of data
- viewing settings and configuration
- changing settings or configuration
- retrieval of fault information

K-bus

The relays are interconnected via a shielded, twisted wire pair known as **K-bus**. Up to 32 relays may be daisychained to form the bus,

The RS-232 port of a remote PC is connected to the K-bus through a protocol convertor, designated KITZ.

K-bus communication signals over the network are **RS-485** based. This offers the advantages of:

- faster signal transmission at 64 kbits/sec.
- total isolation between relays via transformer
- Simplified terminal connection because the connection is not polarity sensitive
- Connections of up to 1000 meters from the RS-232 interface

The K-bus connection to the rear of the relay is shown in **Figure 6**.

The advantage to this system is that up to 32 relays can be accessed through one RS-232 communications port.

Each relay is independently addressable over the bus to allow communication with one relay or more than one relay in the same call. Global commands may also be given to all relays on the network.

Software

Software used with K range relays is designated **Courier**. The Courier language has been developed specifically for communication over the K-bus.

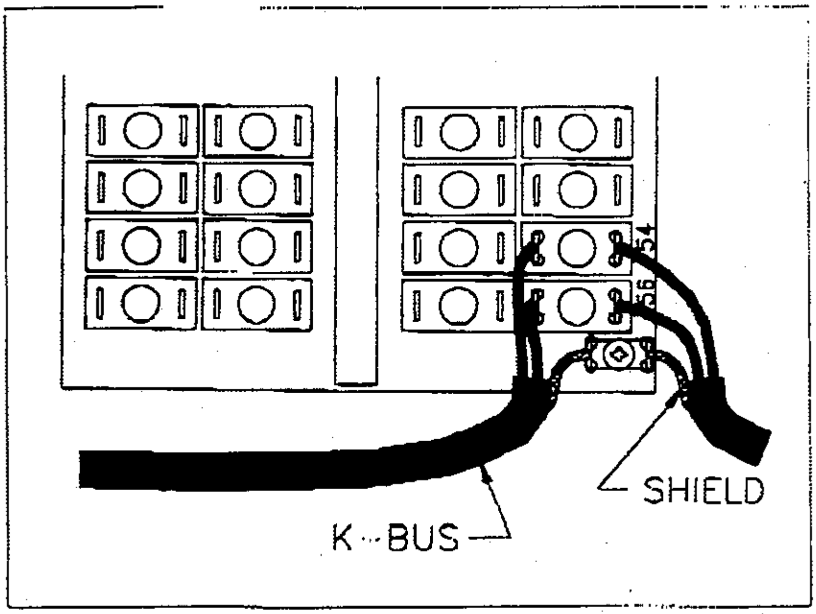


Figure 6: K-bus Connection to Rear of Relay

In the K-bus system, all information resides in the relay. Each time communication is established with a relay, the information is loaded to the software.

The relay is a passive device that only responds to the commands of the software. The software includes extensive error checking routines to ensure the system remains reliable and secure.

Relay Hardware

The K range of relays is a digital design utilizing common hardware components.

Relay Housing

KCEG is housed in the Modular Integrated Drawout System (MIDOS) of GEC ALSTHOM. This provides compact drawout construction with a metallic case and integrally mounted screw type terminal connectors on the rear of each case.

The relays may be either panel mounted (flush, semi-flush or projection) or rack mounted.

The compact modular housing is ideally suited to retrofit applications. The three phase and ground directional overcurrent relay, KCEG140, is housed in a case 6 inches wide by 7 inches high.

Refer to case sizes in the sections entitled **Physical Dimensions** and **Models Available.**

Power Requirements

Two models are available depending upon power sources available.
Auxiliary Powered models accept connections from either AC or DC sources.

Dual Powered models accept connections to AC or DC sources as well as connection directly to the CTs.

When the relays are CT powered, a capacitor is charged by the CT output to provide a trip output directly to the circuit breaker trip coil. If the breaker closes onto a fault, the capacitor is recharged from the fault current of the CT to retrip. Therefore, the system remains secure even if the auxiliary supply is lost.

The minimum current required to power the relay is as follows, where In is the rated current:

Phase faults:	0.4 In (2A for 5A CT)
Ground faults:	0.2 In (1A for 5A CT)

Information Required with Order:

- Relay type
- Operate voltage (100 series)
- CT secondary rating

Technical Data

Ratings

Inputs	
AC current (In)	5A or 1A
AC voltage (Vn)	110V phase to phase
Frequency	50/60Hz
Auxiliary Voltage (Vx)	
KCEG100 aux powered	24/125 Vac or Vdc48/250 Vac or Vd
KCEG200 dual powered	100/120 Vac
Outputs	
Field Voltage	48 V DC (Current limited to 60mA)
Capacitor discharge trip	50Vdc, 680 μF (dual power)

Burdens

AC current	
Aux powered	Less than 0.3 VA at In
Dual powered	Less than 3.0VA at In
AC reference voltage	1W per phase
AC auxiliary voltage	6 VA
DC auxiliary voltage	4W

Overcurrent Settings

	Aux Powered	Dual Powered
Phase Fault	(In = nominal current)	(Is = start current)
I>	0.08 - 3.2 In	0.4 - 2.4 In
I>>	0.08 - 32 In	0.4 - 32 In
I>>>	0.08 - 32 In	0.4 - 32 In
I<	0.08 - 3.2 In	0.02 - 3.2 In
Ground Fault		
Io>	0.02 - 0.8 In	0.02 - 0.8 In*
Io>>	0.02 - 8.0 In	0.02 - 8.0 In*
Io>>>	0.02 - 8.0 In	0.02 - 8.0 In*
Reset	0.95 Is	0.95 Is

*Note: For operation of ground fault below 0.2 In there must be sufficient load current to power the relay or an auxiliary supply must be used.

Directional Settings

Characteristic Angle	- 95° to + 95° in 1° steps
Zone of operation	Characteristic angle ± 90°
Voltage polarizing threshold (Overcurrent elements)	0.5V fixed
Voltage polarizing threshold Vp> (ground fault elements)	0.5V to22V in 0.5V steps
Current polarizing threshold Ip> (dual polarized gnd flt elements)	0.005In to 0.05In (In = nominal current)
Undervoltage trip threshold V< (when overcurrent protection provided)	1.0V to 220V in 1.0V steps

Setting Ranges

Time Settings

to>/t>	0 to 100 sec.
t RESET	0 to 60 sec.
to>>/t>>	0 to 10 sec.
to>>>/t>>>	0 to 10 sec.
tAUX 1	0 to 14.4 killisec.
tAUX 2	0 to 14.4 killisec
tAUX3	0 to 14.4 killisec
tCLS	0 to 14.4 killisec
tBF	0 to 10 sec.
t TRIP/CLOSE	0.5 to 2.0 sec.
t RESTORE	0 to 100 sec.

Time Curves

Standard Inverse

Very Inverse

Extreme Inverse

Long Time Inverse

Opto-isolated control inputs

Single phase, two phase and gnd fault	3
Three phase, three phase and gnd and dual polarized gnd fault	8

Contacts and Ratings

Output Relays		
Single phase, two phase and gnd fault		4 N.O. contacts
Three phase, three phase and gnd and dual polarized gnd fault		8 N.O. contacts
Watchdog Relay		1 N.O. and 1 N.C. contact
Contact Ratings		
Output Relays	Make	30A and carry for 0.2 sec
	Carry	5A continuous
	Break	DC: 50W resistive 25W inductive (L/R = 0.04 sec AC: 1250VA (5A Max)
Watchdog Relay	Make	10A and carry for 0.2 sec
	Carry	5A continuous
	Break	DC: 30W resistive 15W inductive (L/R = 0.04 sec AC: 1250VA (5A Max) Subject to maximum of 5A and 300

Transformer Ratios

Current Transformer	1:1 to 9999:1
Voltage Transformer	1:1 to 9999:1

Operation Indicator

Light Emitting Diodes	3; internally powered
Liquid Crystal Display	16 character by 2 line, backlit

Communication Port

Language	Courier
Transmission	Synchronous; RS-485 voltage levels
Format	HDLC
Baud Rate	64k/bit per second
K-bus Cable	Screened twisted pair
K-bus cable length	3250 feet
K-bus Loading	32 units (multi-drop system)

High Voltage Withstand

Insulation

- 2kV rms for 1 minute;between terminals to case gnd
- 2kV rms for 1 minute between terminals of independent circuits
- 1.5kV rms across open contacts of output relays 0 - 7
- 1.0kV rms for 1 minute across oper contacts of watchdog relay

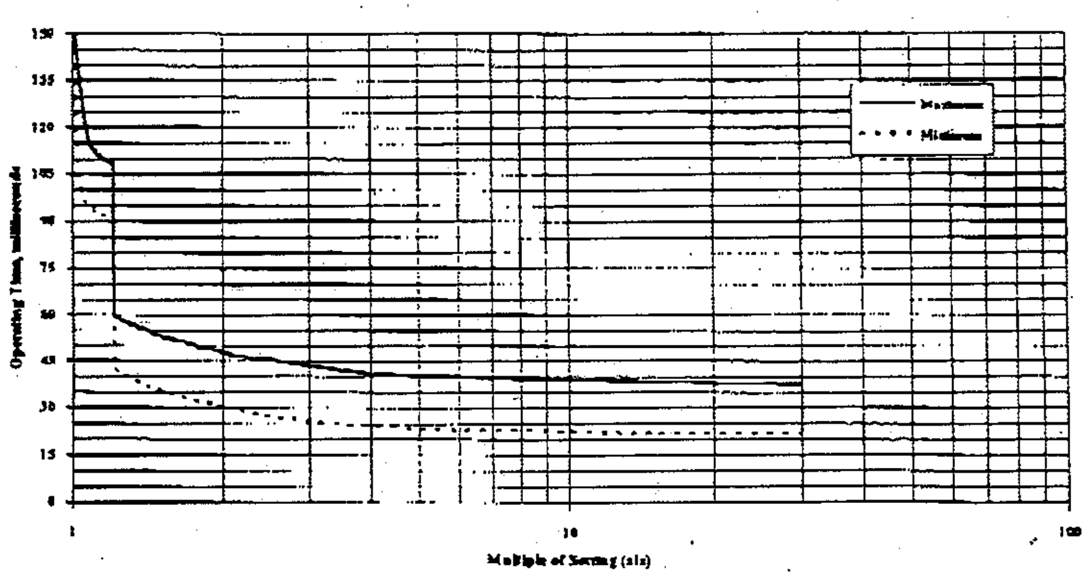
Impulse (IEC255-5)	• 5kV peak, 1.2/50msec, 0.5J between all terminals to case gnd
High Frequency Disturbance (IEC255-22-1/2)	• 2.5kV peak between independent circuits and case
ANSI/IEEE Standards	- Complies with applicable C37.90

Environmental Withstand

Temperature (IEC 68-2-3):	
Storage and Transit	-25° C to +70° C
Operating	-25° C to +55° C
Humidity	56 days at 93% RH and 40° C
Enclosure Protection	IP50 (Dust protected)
Vibration (IEC255-21-1)	• 0.5g between 60Hz and 600Hz • 0.07mm peak to peak between 10Hz and 60Hz
Mechanical Durability	
Contacts loaded	10,000 operations minimum
Contacts not loaded	100,000 operations minimum

Operate Time; KCEG Instantaneous Units

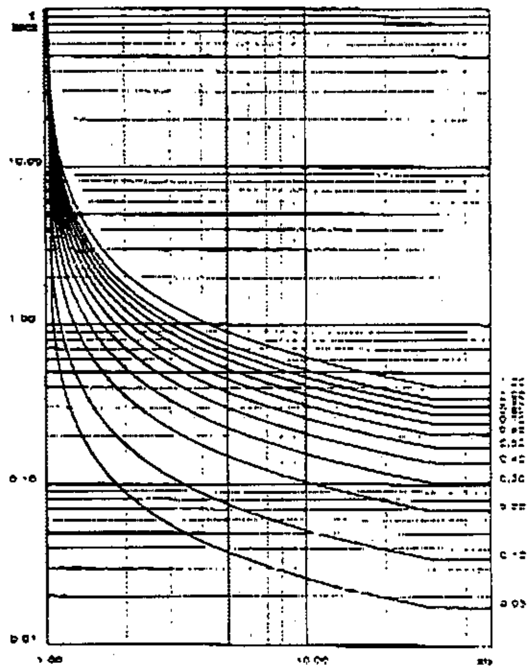
Operating Time of the KCEG I>>, Io>>, I>>> & Io>>>



Short Time Inverse

(Definite Time above 30 x Is)

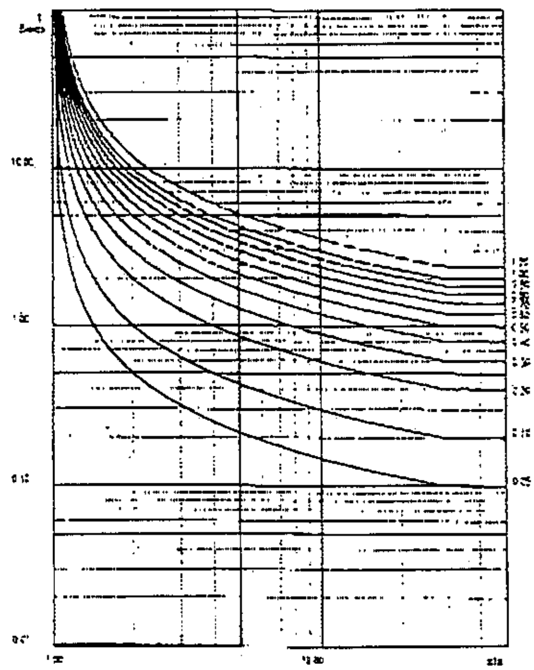
CHARACTERISTIC CURVES FOR KCGG/KCGU/KCEG/KCEU RELAYS



Curve 1 - STX30DT Short Time Inverse - Definite time above 30xIs

Standard (Moderate) Inverse

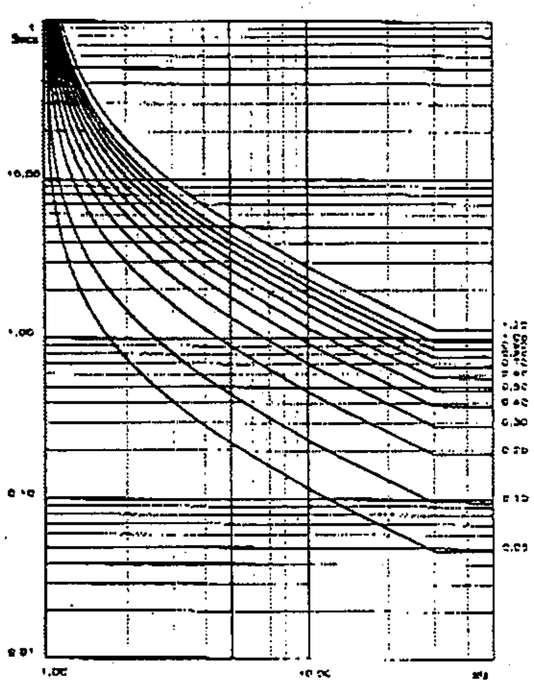
(Definite Time above 30 x Is)



Curve 2 - SIX30DT Standard Inverse (Moderately Inverse) - Definite time above 30xIs

Inverse

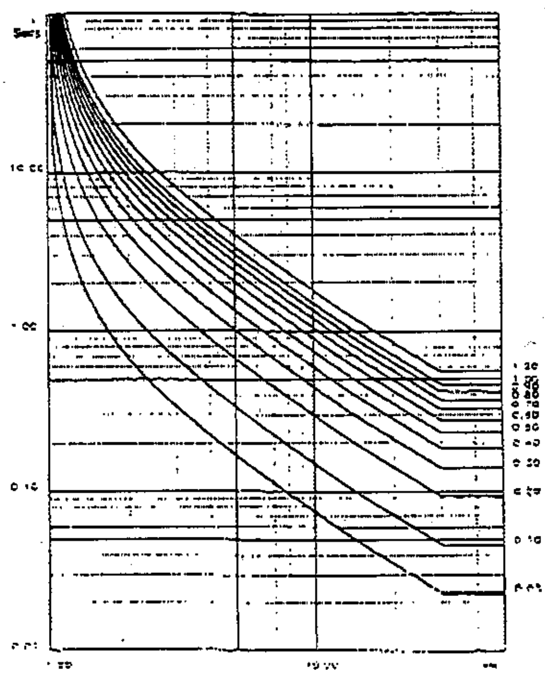
(Definite Time above 30 x Is)



Curve 3 - INX30DT Inverse Definite time above 30xIs

Very Inverse

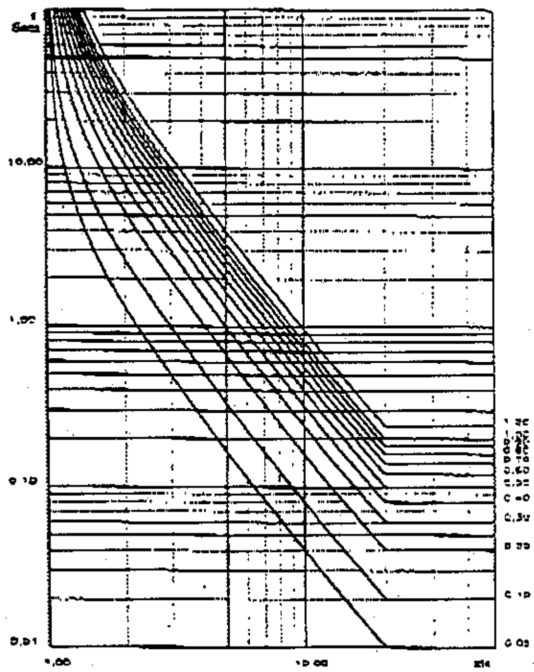
(Definite Time above 30 x Is)



Curve 4 - VIX30DT Very Inverse - Definite time above 30xIs

Extremely Inverse

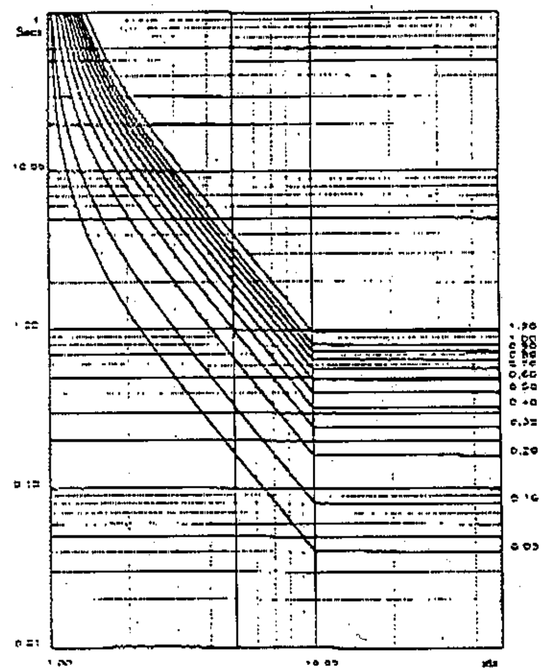
(Definite Time above 20 x Is)



Curve 5 - EIX20DT Extremely Inverse - Definite time above 20xIs

Extremely Inverse

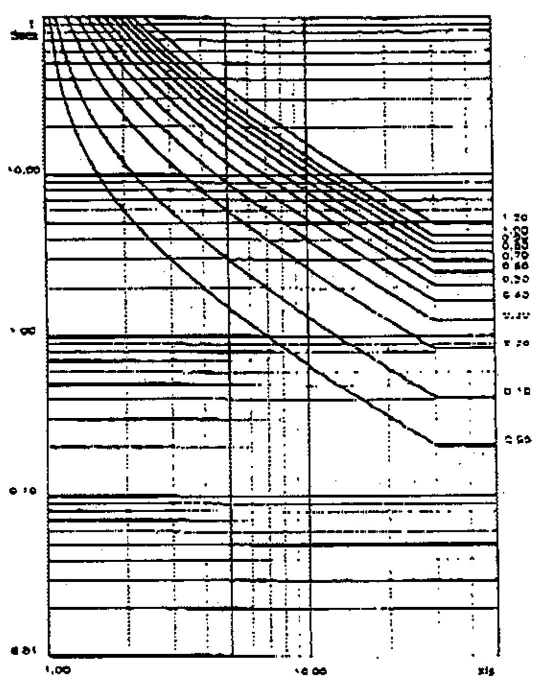
(Definite Time above 10 x Is)



Curve 6 - EIX10DT Extremely Inverse - Definite time above 10xIs

Long Time Inverse

(Definite Time above 30 x Is)



Curve 7 - LTX30DT Long Time Inverse - Definite time above 30xIs

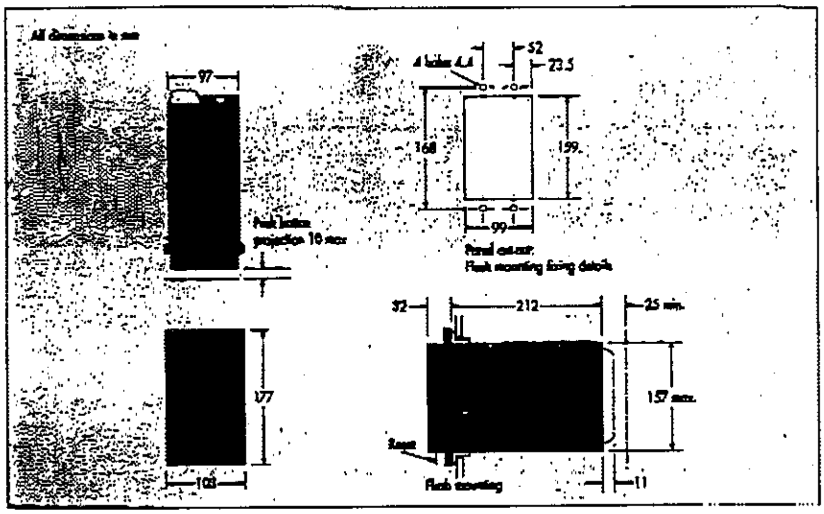
KCEG Models Available

Note: Other models are available for special applications requiring sensitive ground fault protection. Please contact the factory for additional information.

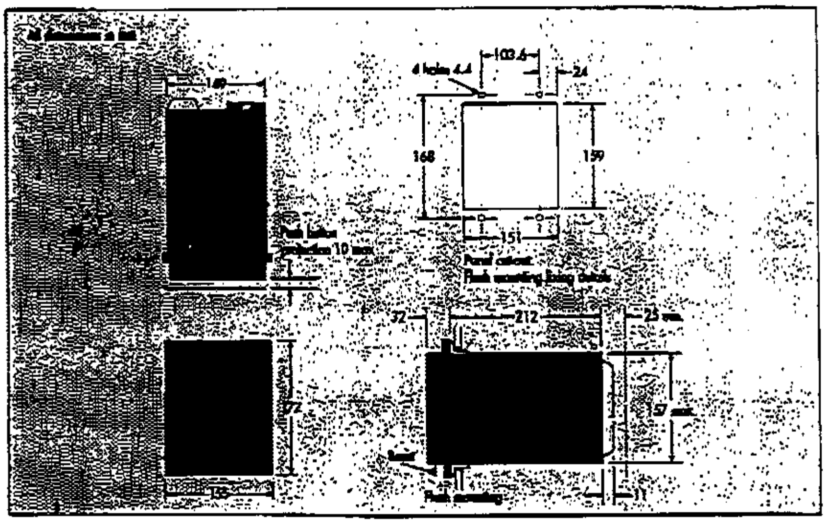
Application / Feature	Directional Ground Fault	Directional Three Phase	Directional Three Phase & Directional Ground Fault	Non-dir Three Phase & Directional Gnd Fault	Dual Polarized Directional Ground Fault
Auxiliary Powered	110	130	140	150	160
Dual Powered	210	230	240	250	
Undercurrent		#	#	#	
Undervoltage		#	#		
Measurement; Current	#	#	#	#	#
Measurement; Phase Voltage		#	#		
Measurement; Zero Seq. Volts	#		#	#	#
Programmable Logic Control Inputs	3	8	8	8	8
Programmable Output Relays	4	8	8	8	8
Load Shed: voltage reduction		#	#	#	#
Load Shed: load trip/restore		#	#	#	#
CB Control: close/trip		#	#	#	#
Auto Reset Trip LED		#	#	#	
Case Size; Aux Powered	4	6	6	6	4
Case Size; Dual Powered	8	8	8	8	

Publication US 6502-A

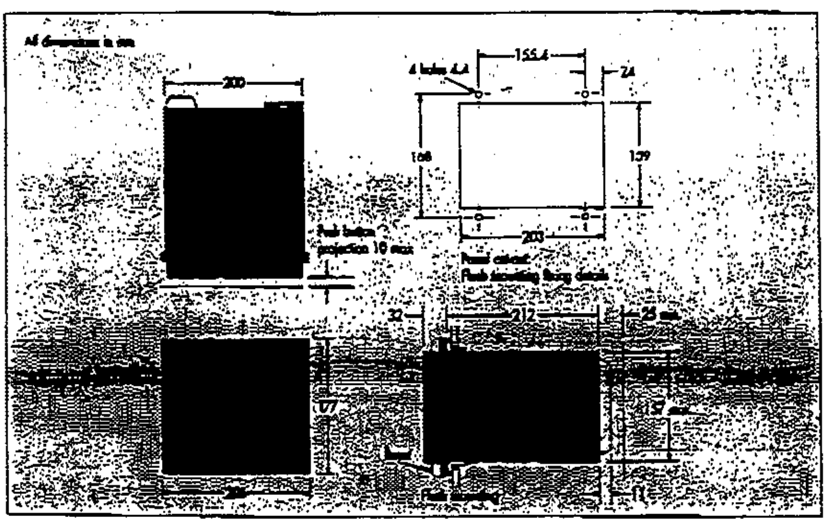
Physical Dimensions: Outline and Drilling



Case Size 4



Case Size 6



Case Size 8

Relay Cases

One of the prime design objectives has been better space utilisation on racks and panels. This has been achieved in a manner consistent with good engineering practice. Each relay is housed in a case of size best suited to its needs and all relays are conservatively thermally rated.

All relay cases have a standard overall height of 177mm complying with IEC 297 size 4U.

Six case widths are used:
Size 2, 3, 4, 6, 8 and 16 each in multiples of 25.9mm.

The case wall is manufactured from a single sheet of hot dipped galvanised steel having a coating of Plastisol PVC on the outside and a polyester finish on the inside. This light, strong material has been selected for its many benefits. It has an exceptional resistance to corrosion, and is flame resistant. It also has better heat dissipation than is possible with plastic cases, and this allows all relays in the range to be given a conservative thermal rating, with good electromagnetic and electrostatic screening properties. The screening effect allows relays to be located next to each other without restraint, thus providing the scheme designer with extra flexibility.

Earth continuity is achieved by a stainless steel strip on the inside of the case which is solidly riveted to secure the joint in the sheet steel. The steel strip acts as a continuous earth contact with which the leaf spring attached to the middle makes contact. It is brought out of the rear of the case above the terminal block, where it forms a separate earthing terminal.

All cases have front mounting flanges which enable relays to be rack mounted or flush mounted on panels without alteration. These flanges are also used to secure the relay cover.

At the rear of the case there are mounting channels which accept slide-on joining strips to produce rigid multi-relay assemblies.

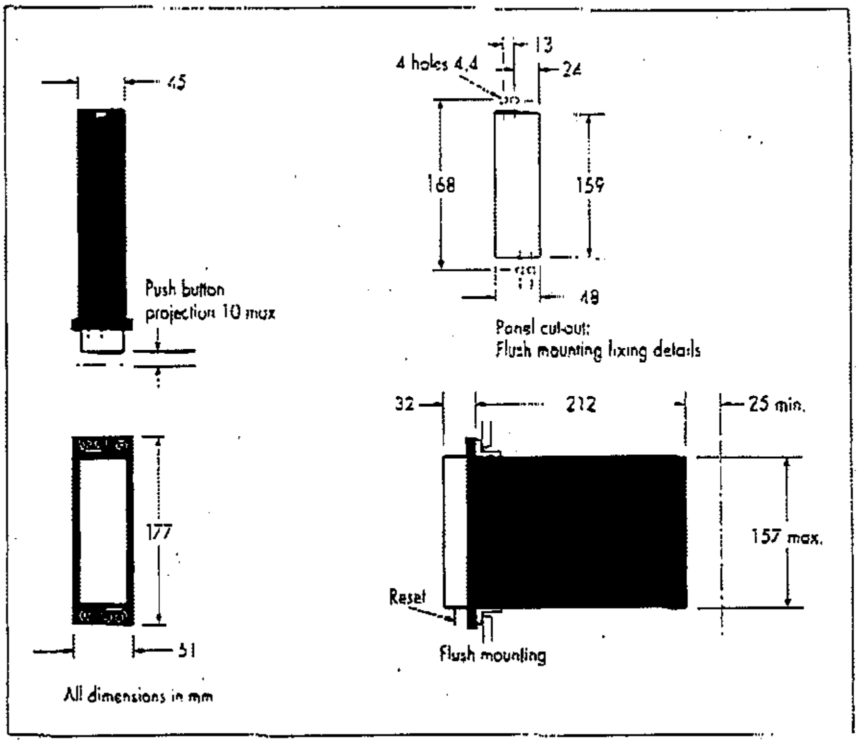
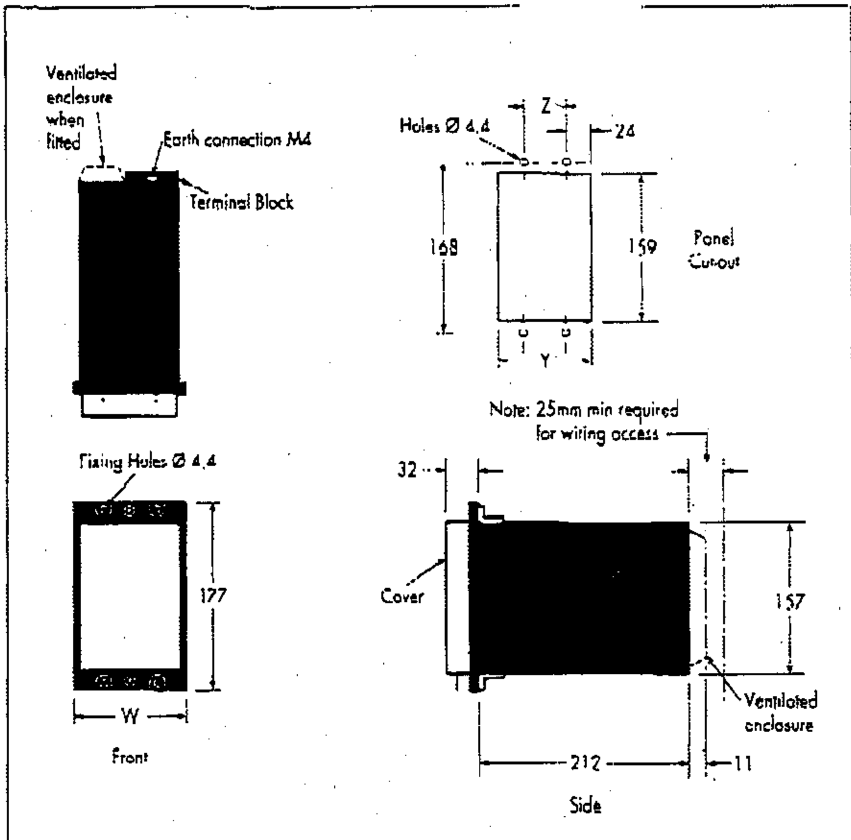


Figure 2: Case and panel cut-out dimensions for relay case size 2



Dimensions in mm	Case size 3	4	6	8	16
W	77	102	155	206	414
X	71	97	149	200	408
Y	73	99	151	202	411
Z	[illegible]	[illegible]	102.6	[illegible]	[illegible]

Figure 3: Case and panel cut-out dimensions for relay case sizes 3 to 16