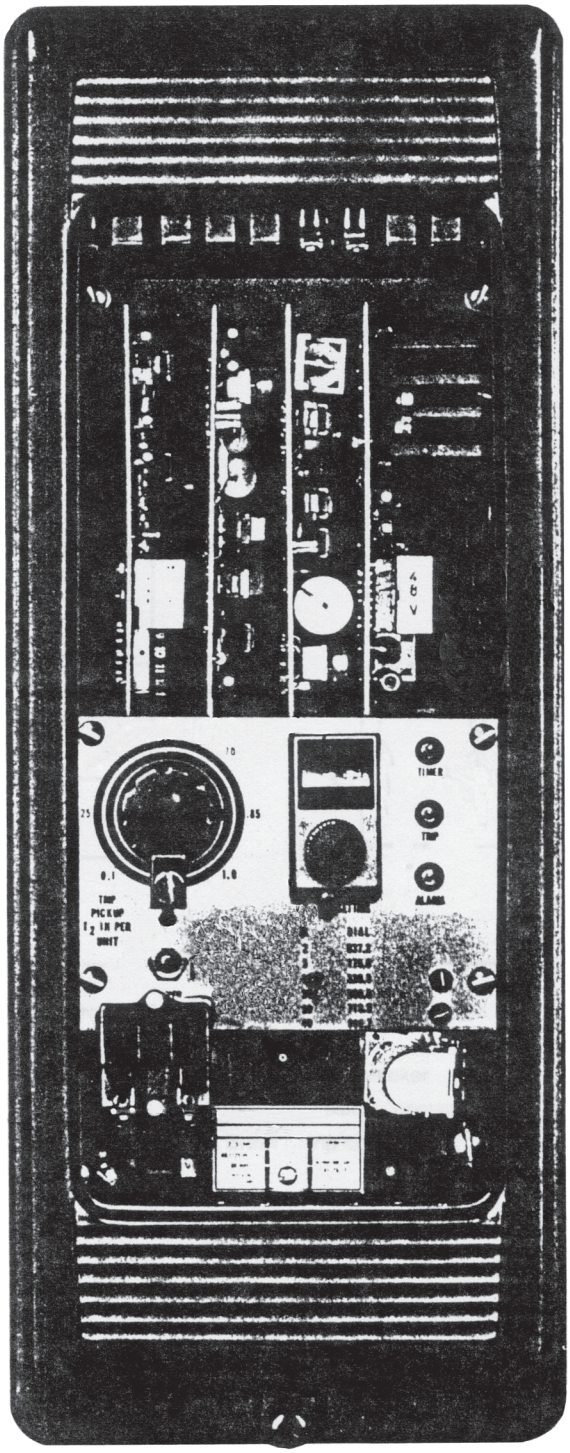
ABB Power T&D Company Inc.
Power Automation & Protection Division
Coral Springs, FL
Allentown, PA

April 1998
Supersedes DB 41-178S
dated August 1991
Mailed to: E,D, C/41-100B

For Protection of Rotating Machinery
Device Number : 46

Type SOQ Negative Sequence Time Overcurrent Relay



APPLICATION

The SOQ negative sequence time overcurrent relay is used to protect rotating machinery against excessive heating damage because of prolonged current unbalance.

The relay is suitable for use with directly or indirectly-cooled turbine generators, synchronous condensers, or any rotating machinery having a known I2_2t limit.

An alarm feature in the SOQ relay alerts an operator to an abnormal I_2 level in the machine being monitored. This feature can be set from 0.03 to 0.20 per unit.

The relay is also equipped with the provision for remote indication of per unit I2 level flowing in the machine. Using this option an operator can estimate the severity of the unbalanced loading and take appropriate action.

Settings of the SOQ relay are compatible with ANSI standard requirements for I2_2t limits for generators, covering the range from 2 to 40. The relay has per unit adjustment allowing it to be related to the full load current of the machine. The I2 trip pickup can be independently adjusted from 0.1 to 1.0 per unit, thus allowing time delayed tripping to occur at any I2_ level above this point.

The exponential resetting action of the SOQ relay's timer has been made compatible with that of air-cooled and hydrogen turbine generators.

Rotating Machine

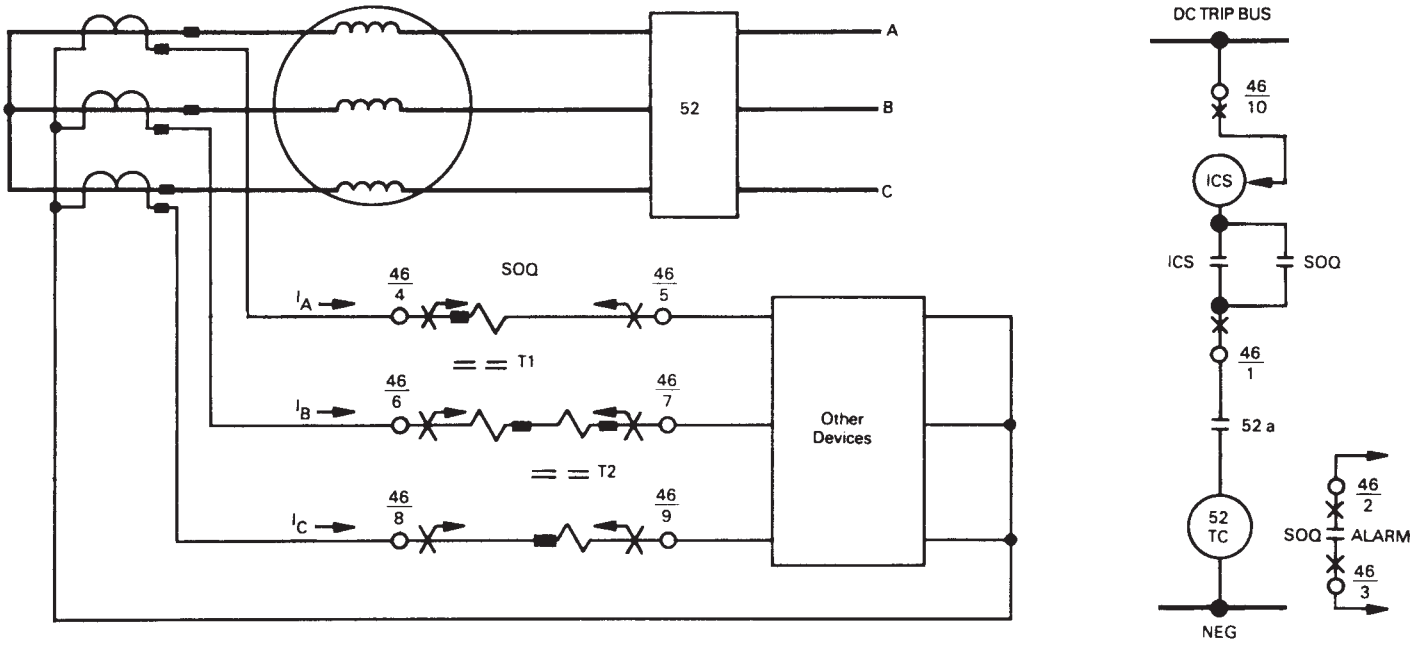
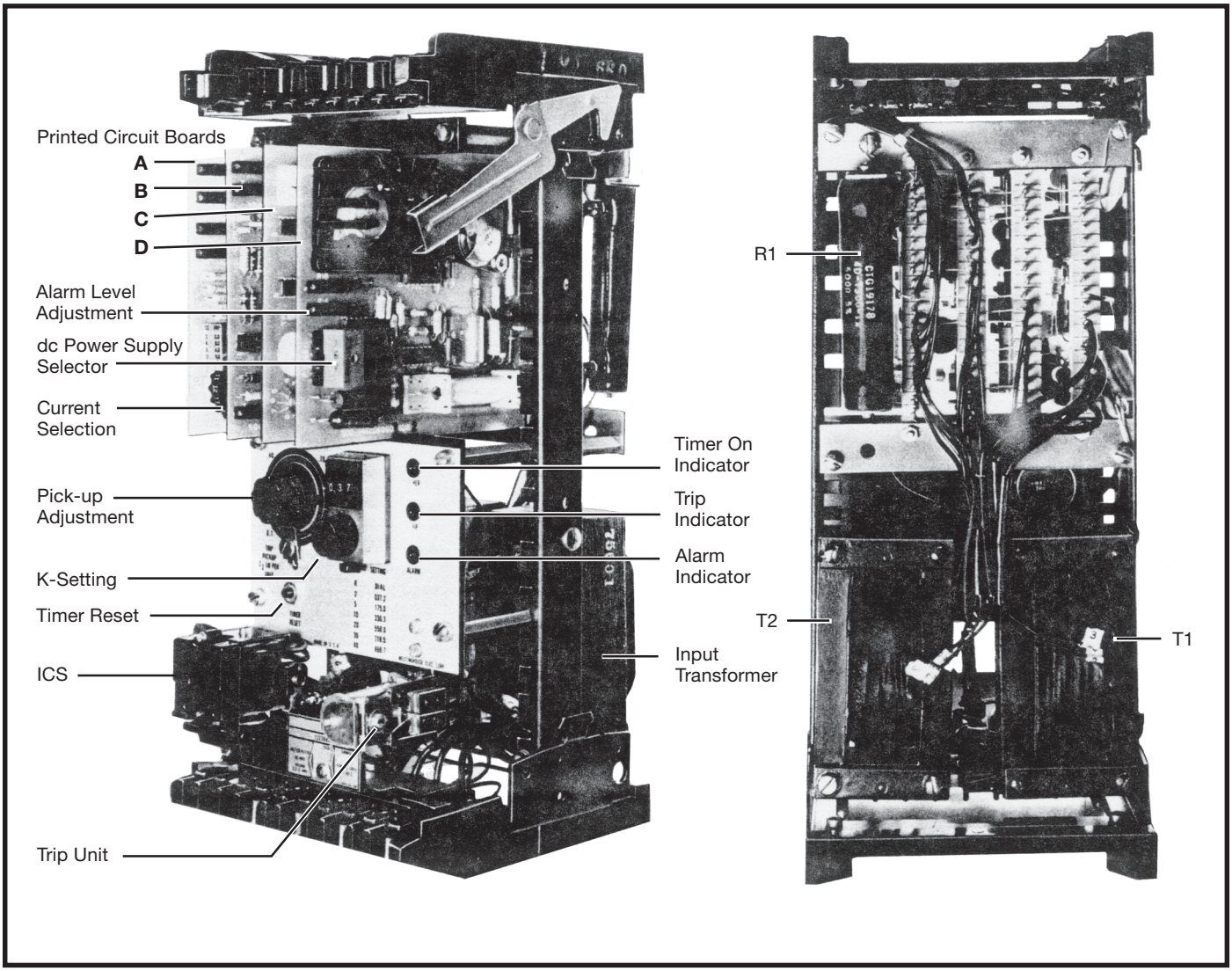


Figure 1. System application Diagram of the SOQ Relay

Device Number Chart

46	Negative sequence Generator relay type SOQ	52	Power circuit breaker
		a	Breaker auxiliary contact
ICS	Indicating Contactor Switch in SOQ relay	TC	Breaker trip coil

CONSTRUCTION



Printed Circuit Boards - slide into position and engage into a terminal block at the rear of the relay. The boards and terminal blocks are notched preventing insertion into the wrong position. Each board may be removed and used in conjunction with an extender board (Style No. 644B315G02) permitting access to test points and terminals while the relay is energized.

(A) Input Board
(B) Timer Board
(C) Control Board
(D) Power Supply Board

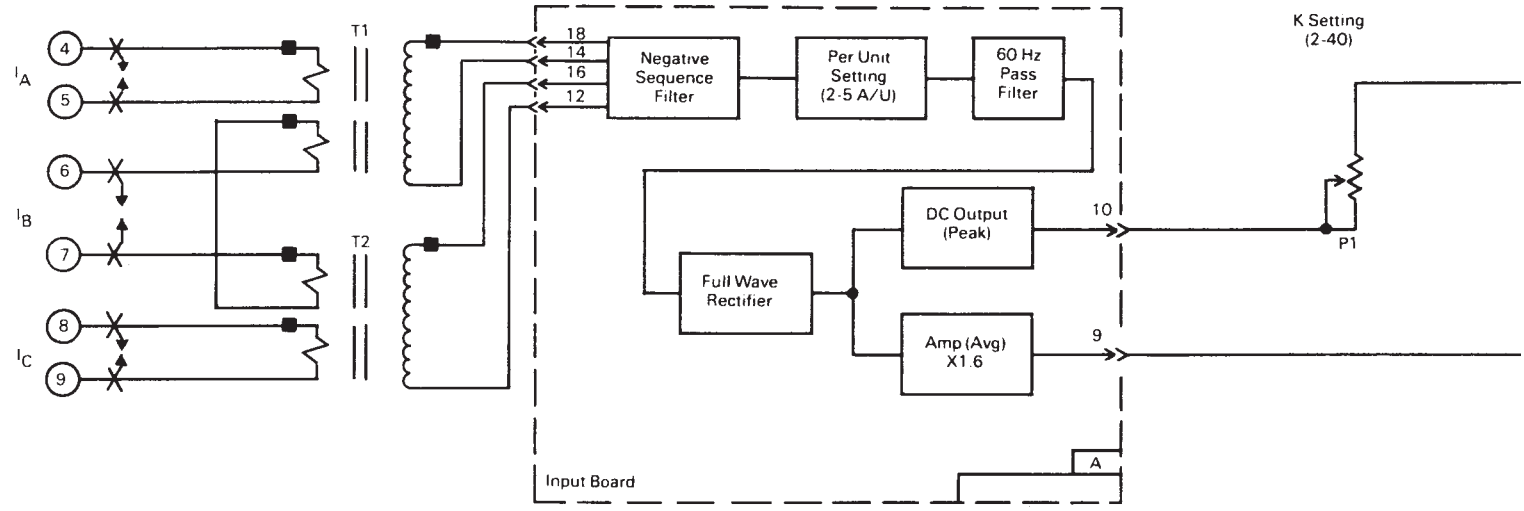
Panel & Dial Plate - contains the ten-turn potentiometer used for the K-setting and the single-turn potentiometer to set the trip pickup level. The panel also contains three (3) light-emitting diodes for timer-on, trip and alarm condition indication. A pushbutton is utilized to reset the timer and its associate LED. This function is used primarily for routine relay testing.

Output Contacts - A telephone type relay is provided with two Type A contacts. One of the normally open contacts is used with the target seal in unit when tripping. There are also two normally open contact (N.O.C.) reed relays, one mounted on the Power Supply Board and the other on the Control Board, sued for the alarm and oscillograph start function respectively.

Indicating Contactor Switch - The dc indicating contactor switch is a small clapper type device. A magnetic armature, to which leaf-spring mounted contacts are attached, is attracted to the magnetic core upon energization of the switch. When the switch closes the moving contacts, completing the trip circuit. Also during this operation two fingers on the armature deflect a spring located on the front of the switch, which allows the operation indicator target to drop. The front spring, in addition to holding the target, provides restraint for the armature and thus controls the pickup value of the switch.

Remote Readout Instrument (Optional)- may be provided to allow monitoring the negative sequence current (I^2) level at a remote location. The instrument provided is a Weshler switchboard type KX-241 (4 1/2", 250° scale, 1% accuracy). It is a 1 mA dc instrument marked to represent 0.2 per unit at full scale.

Fig. 2 Internal Logic Diagram



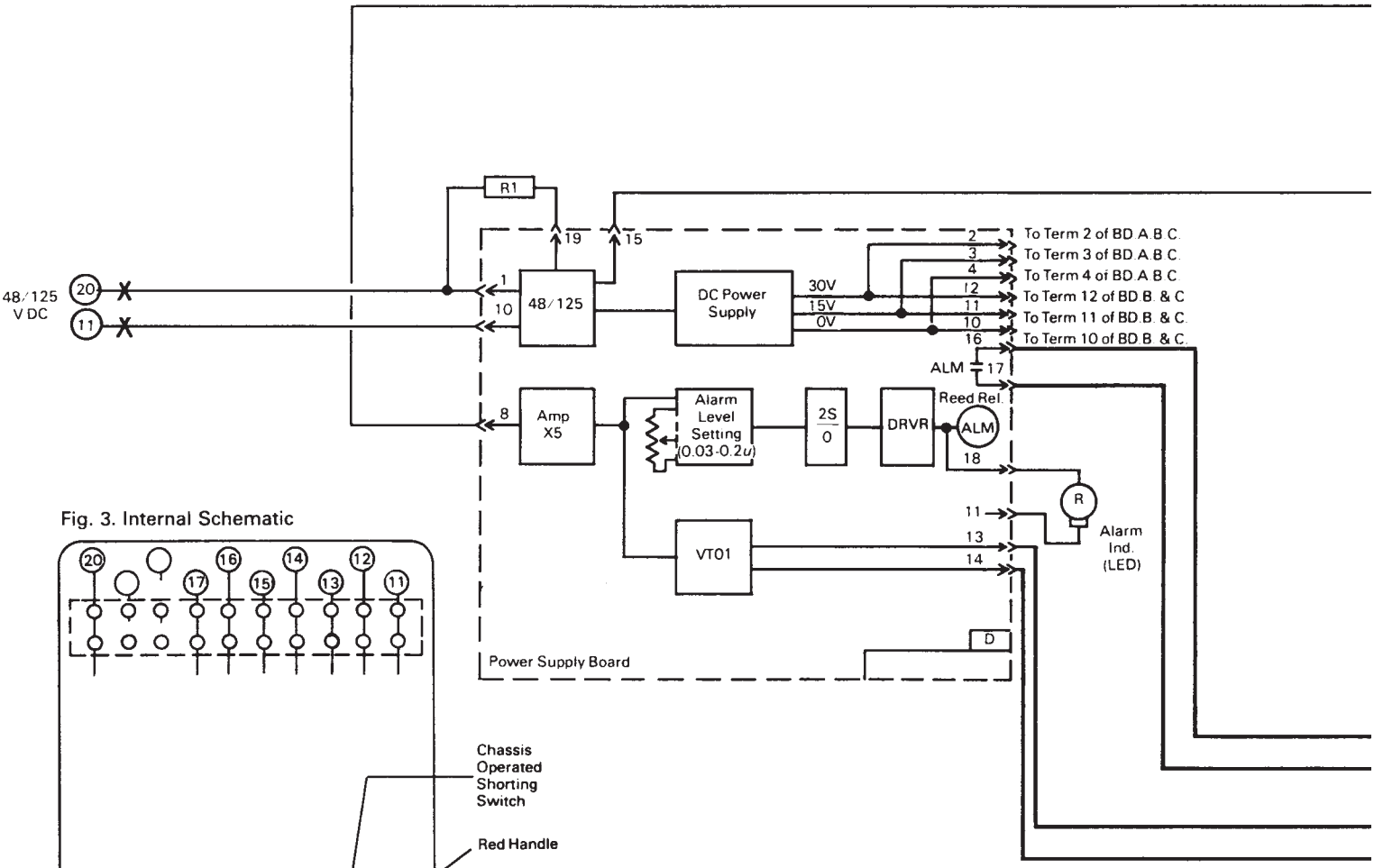
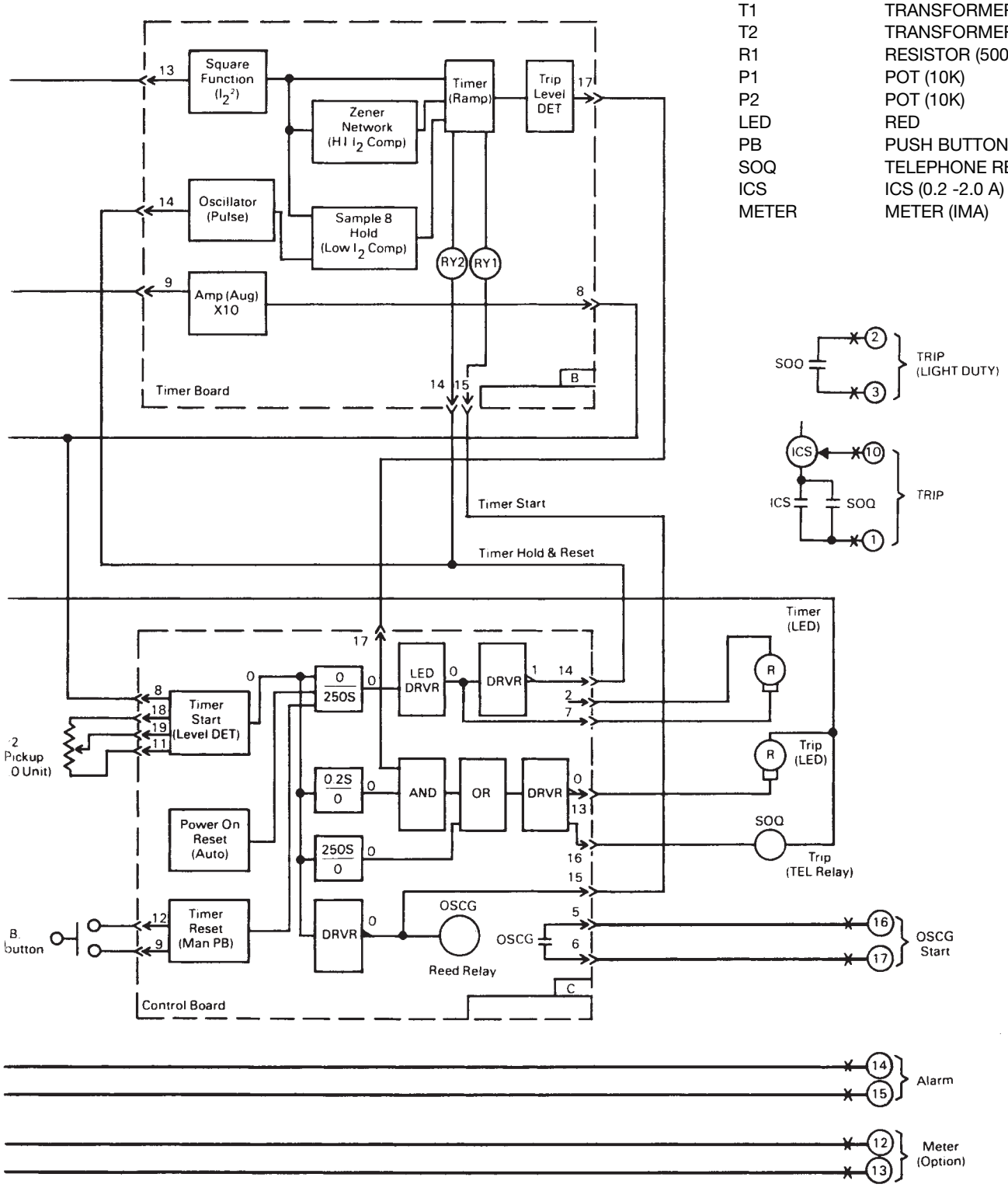


Fig. 3. Internal Schematic

Component	Description
T1	TRANSFORMER
T2	TRANSFORMER
R1	RESISTOR (500 40W)
P1	POT (10K)
P2	POT (10K)
LED	RED
PB	PUSH BUTTON
SOQ	TELEPHONE RELAY
ICS	ICS (0.2 -2.0 A)
METER	METER (IMA)



Operation

The SOQ relay internally simulates a generator's characteristics, $I_2^2t=K$ where:

I_2 = negative sequence current per unit

t = duration of unbalanced operation

K = machine constant

Within the SOQ relay, t = the time delay for tripping.

For a detailed description of the relays operation see Instruction Leaflet 41-161.1.

Settings

The relay requires the following settings to assure correct operating results:

A) Per Unit- choose the setting nearest to, but less than the full load current of the machine converted to relay amperes. For hydrogen cooled machines, this setting should be related to the capability of the machine for the particular hydrogen pressure involved.

B) K-Setting-chosen to correspond to the I_2^2t limit for the particular machine being protected. These are typically:

Type of Machine	$I_2^2t=K$	Dial Setting
Salient Pole	40	860.7
Synchronous Condenser	30	718.5
Cylindrical Rotor		
Indirectly Cooled	30	718.5
Directly Cooled	10 (or less)	330.3 (or less)

C) Trip-pickup level- should the lowest I_2 level at which tripping will be permitted. A^2 reasonable level to consider would be that level of sustained I_2 to produce tripping at 250 seconds.

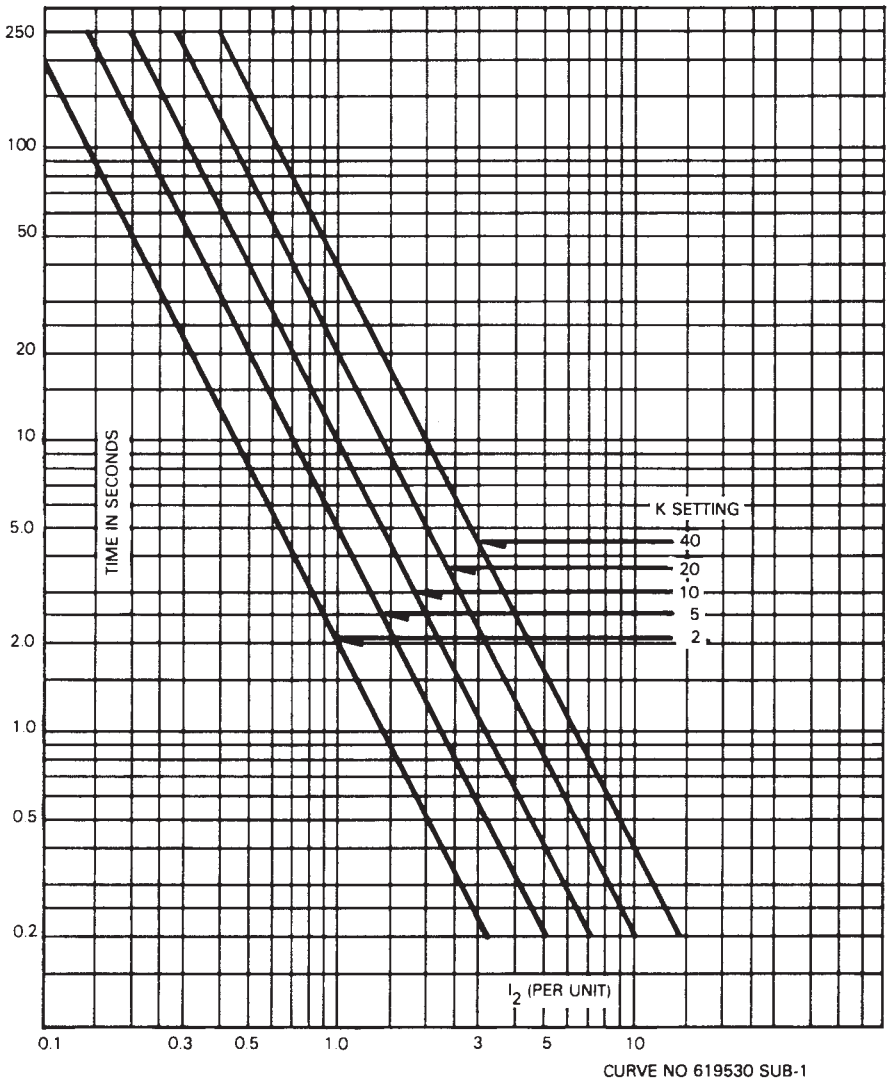
This would be $\sqrt{\frac{k}{250}}$ For example

if K were 10 for the protected machine, the level would be adjusted for

$I_2 = \sqrt{\frac{10}{250}} = 0.2$ per unit.

D) Alarm Level- should be set at the lowest level consistent with normal load unbalance but in no case greater than the maximum continuous I_2 level for the machine. Typical values for generators are:

Fig. 4 Typical Time Current Curves



CURVE NO 619530 SUB-1

Type of Machine	Permissible I_2 (%)
Salient Pole	
with connected amortisseir windings	10
with nonconnected amortisseir windings	5
Cylindrical Rotor	
Indirectly cooled	10
Directly cooled	
0 to 960 MVA	8
961 to 1200 MVA	6
1201 to 1500 MVA	5

For a machine with a continuous I_2 capability of 10%, a reasonable alarm level setting is 0.05 (that is, 5%).

E) Timer- within the SOQ has an inverse resetting characteristic similar to that of typical generators to allow for any cumulative effects which may, for example, take place during reclosing.

Two conservative values are available and may be chose by a "link" on the Timer Board.

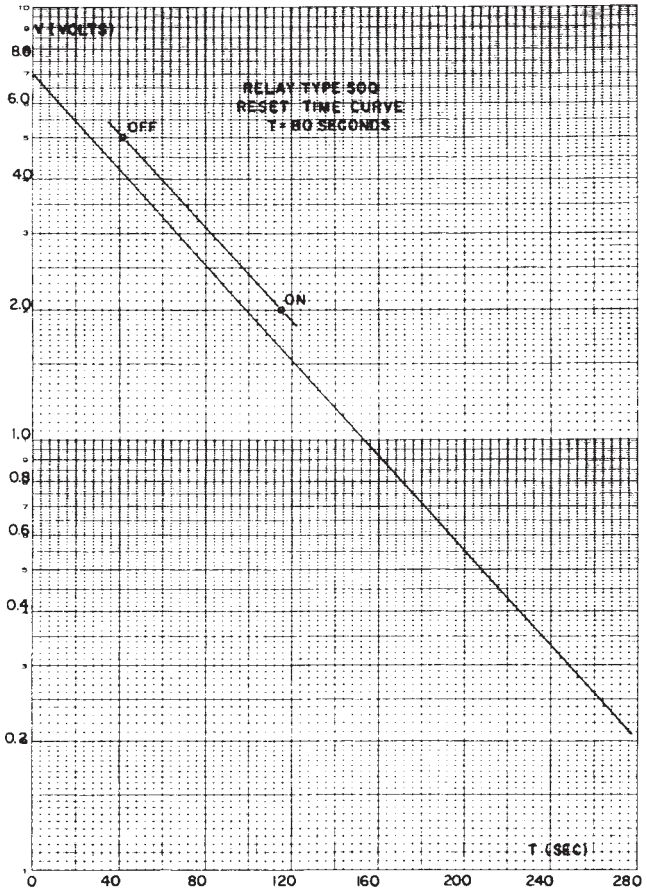
The cooling time constant for hydrogen-cooled turbine generators is typically less than 40 seconds, for air-cooled machines it is typically less than 80 seconds.

By leaving the link "in" a time constant of 38 seconds is applied. With the link "out", a constant of 80 seconds is chosen.

In the absence of specific information, the link should be removed, suing the 80 second time constant. Where the actual cooling time constant is known, the lowest value that is higher than the machine time constant should be selected.

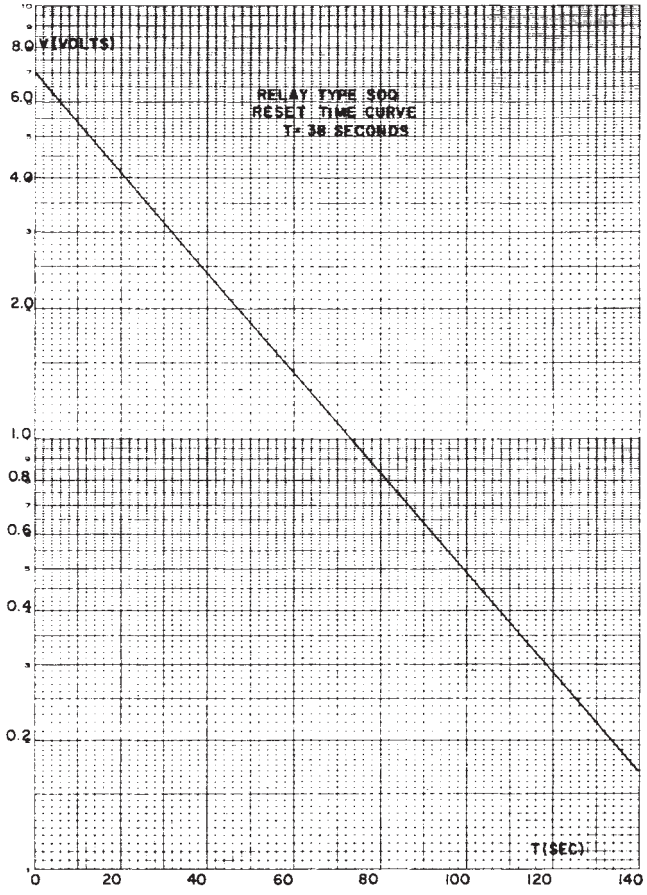
Remove the link where reclosing is not applied.

Fig. 5. Reset Time Curve for Time Constant 80 Seconds



Curve No. 619531

Fig. 6. Reset Time Curve for Time Constant 38 Seconds



Curve No. 619532

Overcurrent, Negative Sequence, Three Phase (Device Number: 46)

Type and Contacts	Application	Neutral Location	Indicating Contactor Switch ③	Time Unit Current Range: Amps Ac	Circuit Control Volts: Dc	**Relay Data** Internal Schematic	Style Number	Case Size
SOQ	Generator Protection	.....	0.2/.20 amp dc	2-40 (I_2^2t)	48-125	1334D69	1333D85A01 1333D85A02 ④	**FT-32**

③ ICS Indicating contactor Switch (dc current operated) having seal-in contacts and indicating target which are actuated when the ICS coil is energized at or above pickup current setting. Suitable for dc control voltages up to and including 250 volts dc. Two current ranges available:
(1) 0.2/2.0 amps dc, with tapped coil
(2) 1.0 amp dc, without taps

Rating of ICS unit used in specific types of relays is shown in price tables. All other ratings must be negotiated.

When ac current is necessary in a control trip circuit, the ICS unit can be replaced by an ACS unit.

The ACS unit may be supplied in place of an ICS unit at no additional cost. Specify system voltage rating on order.

④ Includes remote monitor negative sequence current type KX241.

CHARACTERISTICS

Ambient Temperature	-20° to +55°C
Current Transformer	Continuous rating - 10 amperes
	One second rating - 300 amperes
Constant K Setting	2 to 40 - 2%
Current Range Setting	2 to 5 amperes per unit with 0.25 amperes per step
Operating Time	0.2 to 50 seconds - 5%
	50 to 250 seconds - 10%
Timer Start Pickup	0.1 to 1.0 per unit - 5%
Alarm Pickup	0.03 to 0.2 per unit - 5%
Alarm Time Delay	2 seconds - 25%
Initial Disable Trip Time	0.2 second - 10%
Final Trip Time	250 second - 10%
Reset Exponential Time Constant	38 or 80 seconds - 10%
Frequency Response at	No response to 57 Hz. positive sequence current 5 amperes
DC Power Supply	48/125 Volts
DC Current Drain	0.17 ampere (max.)
Burden (ac)	1.6 volt -ampere (max.) at 5 amperes and 60 Hz.
Indicating Contactor Switch (ICS)	0.2/2 amperes
Contact Rating:	1. Trip contacts with ICS - 30 amperes at 250 volts dc for 0.2 second.
	2. Trip contacts (telephone relay) - 0.1 ampere at 125 Vdc.
	3. Alarm contacts (reed relay) - 0.1 ampere at 125 Vdc.
	4. Oscillograph start (reed relay) - 0.1 ampere at 125 Vdc.

Further Information

List Prices: PL 41-020

Technical Date: TD 41-025

Instructions: IL 41-161.2

Flexitest Case Dimensions: DB 41-076

Other Protective Relays:
Application Selector Guide TD 41-016

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