Type ITH-T Relay

Effective: December 1989

NEW INFORMATION

CAUTION

Caution putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the setting and electrical connections.

1.0 APPLICATION

This 3-phase relay with individual phase indication is intended for use in applications where a non directional high dropout ratio overcurrent unit is required and a short time delay is needed to prevent operation on such things as transformer inrush current or dc offset current.

This relay may be used on the supply side of a transformer to provide improved sensitivity and still coordinate on a time basis with downstream devices.

2.0 CONTENT

The relay consists of three high dropout instantaneous units with an equal number of operation indicators, one contactor switch, and a timing circuit.

3.0 CONSTRUCTION

3.1 THE HIGH DROPOUT INSTANTANEOUS TRIP UNIT (ITH)

The high dropout instantaneous trip unit is a small solenoid type device. A plunger assembly rides up and down on a vertical guide rod in the center of the solenoid coil. The plunger assembly consists of a bushing which is threaded on the moving plunger and locked in place by a nut, and a silver disc which rests on a helical compression spring at the lower end of the plunger. The guide rod is fastened to the stationary core which in turn is held in place by the insulating plate on which the stationary contacts are mounted. The stationary core consists of two steel sections separated by a non-magnetic ring. This non-magnetic ring provides an air gap in which the plunger steel floats. When the coil is energized, the plunger assembly moves upward carrying the silver disc which bridges three spring type conical shaped stationary contacts. In this position, the helical spring is compressed and the plunger is free to move while the contact disc remains stationary. Thus, ac vibrations of the plunger assembly are prevented from causing contact chattering. A Micarta disc which acts as a shield for the contact plate, screws on the bottom of the guide rod and is locked into position by a small nut. The adjustable screw in the top of the frame provides the principal means for adjusting the current operating values.

3.2 CONTACTOR SWITCH

The dc contactor switch in the relay is a small solenoid type switch. A cylindrical plunger with a silver disc mounted on its lower end moves in the core of the solenoid.

As the plunger travels upward, the disc bridges three silver stationary contacts. The coil is in series with the main contacts of the relay and with the trip coil of the breaker. When the relay contacts close, the coil becomes energized and closes the switch contacts. This shunts the main relay contacts, thereby relieving them of the duty of carrying tripping current. These contacts provide a seal-in function and remain closed until the trip circuit is opened by the auxiliary switch on the breaker.

3.3 OPERATION INDICATOR

This operation indicator is a small solenoid coil connected in the trip circuit. When the coil is energized a spring-restrained armature releases the white target which falls by gravity to indicate completion of the trip circuit. The indicator may be reset from the outside of the case.

3.4 TIMING FUNCTION

The circuit consists of a reference voltage circuit, a rheostat (P1) and scale plate, a voltage biasing potentiometer (P2), a timing circuit containing static timing components, and an output telephone relay (K1).

3.5 REFERENCE VOLTAGE CIRCUITS

The reference voltage circuit provides a fixed supply voltage to the R-C time delay circuit and protects the static components from high voltages. It consists of a silicon power regulator and a series resistor (R1). The silicon power regulator (Z1) is a 10 watt Zener diode mounted on the printed circuit board. The series resistor (R1) is a 3 1/2 inch resistor which is tapped for 48/125 volt dc relays.

3.6 RHEOSTAT AND SCALE PLATE

The rheostat (P1) provides a variable resistance for the R-C tie delay circuit. It is of wire-wound construction, which minimizes resistance change with temperature. DO NOT remove the knob from the rheostat shaft, since it is not easy to replace the knob in the calibrated position. The timing scale is non-linear as explained in the section under “Timing Circuit”.

3.7 POTENTIOMETER

The potentiometer (P2), provides a biasing voltage which keeps the silicon controlled rectifier (SCR1) turned off until the capaci6tor voltage reaches the potentiometer brush voltage. It is of wire-wound construction and has a locking nut which should not be loosened unless the relay is being re-calibrated.

3.8 TIMING CIRCUIT

The timing circuit contains a diode (D6) which protects the static components in case the relay is connected with reverse polarity, a time limiting resistor (R2), timing capacitor (C1), a parallel resistor (R4) which makes the calibrating scale non-linear, and a silicon controlled rectifier (SCR1). The printed circuit also contains a diode (D1) to reverse bias SCR1, a resistor (R3) and diode (D5) to protect the static components from the inductive voltage kick associated with the telephone relay coil, and series diodes (Dd4, D3, and D2) which compensate for the forward drop through SCR1 an D1 and zener reference variations.

3.9 TELEPHONE RELAY (K1)

The telephone relay (K1) is energized by SCR1 at the conclusion of the time delay. The coil is energized by at least three times pick-up wattage to insure positive contact operation. The contacts are made of palladium and are suitable for circuit breaker trip duty, as proven by many years of experience in other relays.

4.0 OPERATION

The ITH unit is a current operated device which will pick-up within the range stamped on the side of the frame and drop-out at 90% or greater of the pick-up current value. The position of the core screw determines the pick-up value for a particular contact gap. The 90% drop-out ratio is accomplished through the right combination of plunger steel setting, electrical pull and spring strength. The most important factor in the adjustment of the unit is the correct positioning of the plunger steel with respect to the stationary core air gap.

Operation of the timing circuit occurs when a silicon controlled rectifier (SCR1) switches from a non-conducting state to a conducting state. In the non-conducting state, the SCR1 acts as an opened switch to prevent energization of the telephone relay (K1), but in the conducting state acts as a closed switch to connect the telephone relay to the dc source. To switch the SCR1 from a non-conducting state to a conducting state requires that a maximum of 20 microamperes flow in the gate of the SCR1. This current is produced by the difference in voltage across the capacitor (C1) and the brush of the potentiometer (P2).

When the ITH unit of any phase is picked up, the respective operation indicator drops its flag, and the timing circuit is energized.

Voltage instantaneously appears across the potentiometer brush but is delayed in building up across the capacitor in accordance with the R-C time constant of the circuit. As long as the capacitor voltage is less than the potentiometer brush voltage, a reverse voltage appears across the diode D1, and SCR1 to keep the silicon controlled rectifier (SCR1) biased off. When the capacitor voltage reaches the potentiometer brush voltage plus approximately one volt (forward voltage drop across SCR1 and D1), gate current will flow to the silicon controlled rectifier (SCR1). This current switches the SCR1 to a conducting state to allow the telephone relay (K1) to pickup.

The SCR1 latches on when it switches and can be reset only by removing voltage from R1 terminal 2.

The rate at which the capacitor charges is determined by the rheostat setting, since R4 gives a parallel resistive path. This has the effect of expanding the scale for short times and thereby permitting more accurate settings.

5.0 CHARACTERISTICS

5.1 ITH UNIT

The range for the instantaneous units is 20 - 40 amperes.

The unit has a nominal 2 to 1 range of pick-up adjustment with a 90% or greater drop-out ratio. The core screw at the top of the unit is used to change the setting. The maximum core screw setting is ten turns out from the fully bottomed position. At the maximum end of the range it may be necessary to increase the contact gap to obtain the desired pick-up. As long as the setting of the unit is within its nominal rating the drop-out ratio will be 90% or greater.

The nominal range may be extended by increasing the contact gap with the core screw at its maximum position. The drop-out ratio for settings above the nominal range will be below 90%. For example, for a pick-up wetting of three times the minimum setting, the drop-out ratio will be approximately 60%. Likewise, for a setting of four times the minimum setting, the drop-out ratio will be approximately 45%.

The burden of this unit at minimum pick-up is 0.44 VA at 60 hertz.

Characteristic operating times for the unit over its nominal range are:

Less than 1 cycle at 200% of trip value
1/2 cycle at 500% of trip value
1/4 cycle at 1000% of trip value

Continuous current rating of the coil is 2 times minimum pick-up value.

One second rating is approximately 30 times minimum pickup.

5.2 CONTACTOR SWITCH

The contactor switch is a dc operated switch with a pick-up of 2.0 amperes.

5.3 OPERATION INDICATOR

The operation indicator is a 1.0 ampere dc operated indicator with a pick-up of 95% of its rated value.

6.0 CONTACT CIRCUIT CONSTANTS

Resistance of 2.0 ampere
Contactor Switch - - - - 0.25 ohms

Resistance of 1.0 ampere
Operation Indicator - - - 0.16 ohms

Time Delay Range and Voltage Rating

Time Delay Range (seconds)	Voltage Rating (Volts dc)
.05 - 1.0	48 / 125

6.1 BATTERY DRAIN

	48 Volts dc	125 Volts dc
STAND-BY	0	0
OPERATING	270 MA	180 MA

6.2 VOLTAGE RATING OVER THE TEMPERATURE RANGE

The relay can stand 110% voltage continuously over a temperature range of -40°C TO + 70°C.

6.3 REVERSE POLARITY

Diode (D6) limits reverse voltage of the static components to less than one volt dc, so that no damage is done to the circuit by connecting the relay with reverse polarity. However, the relay will, of course, not operate under this condition, and series resistor (R1) may over-heat if reverse voltage is applied for approximately 15 minutes or more.

6.4 RESET TIME

K1 drop-out time = 0.1 second or less.

Discharge of timing capacitor: the discharge of C1 is essentially instantaneous, the RC1 time constant through P2 being less than 20 milliseconds, in most cases. However, the discharge path through P2 is limited by silicon voltage drops through SCR1 and D1, totalling approximately one volt. Therefore, C1 discharges rapidly through P2 down to about one volt and then more slowly through R4 down to zero volts.

6.5 ACCURACY

The accuracy of the time delay depends upon the repetition rate of consecutive timings, the supply voltage, the ambient temperature, and the ITH contact debounce. Self-heating has a negligible effect on the time accuracy.

In consecutive timings, incomplete capacitor discharge will cause changes in time delay. These changes are a function of discharge rate.

Changes in ambient temperature cause changes in time delay. This variation in time delay is a direct function of capacitance change with temperature. Typical variation of time delay with temperature, is shown in Figure 2.

7.0 ACCEPTANCE CHECK

A timing check at minimum and maximum settings is recommended to insure that the relay is in proper working order.

A recommended test circuit is shown in Figure 1.

Set rheostat P1 to minimum and later maximum. Apply 2 times the rated phase current 1 through Terminals 4 and 5. Check respective operation indication and time delay per Table 1.

Repeat for phases B and C and for all phases for minimum and maximum time values.

Table 1

Relay Rating	Delay Between Readings
.05 - 1.0 sec.	at least 3 seconds

* Allowing 30 ms of contact debounce typically.

8.0 CALIBRATION

8.1 ITH UNIT

This unit, prior to shipment is adjusted for minimum pick-up value, that is, the lower value marked on the side of the frame. The following procedure is used when changing this setting over the indicated range where a 90% or higher drop-out ratio is desired. Connect the coil of the unit in series with an ammeter and adjustable load. Apply the desired pick-up current, then adjust the core screw until the plunger just picks-up. Lock core screw securely in place.

If it is d4esired to set the unit for either a different drop-out ratio over the nominal range or for pick-up values above the nominal range, then the following procedure should be followed.

With the desired drop-out current applied, adjust the core screw until the plunger assembly just drops out. Then apply the desired pick-up current and adjust the Micarta contact shield until the plunger just picks up. It is recommended that the contact gap should not be made less than .013 of an inch. The contact gap may be determined by turning up the contact shield from the setting position until the contacts just close.

One turn of the shield is equal to .018 of an inch contact gap.

The factory adjustment of the position of the plunger steel provides a drop-out ratio of 90% over the nominal range. But in the event of a considerable amount of material is removed from the contacts due to repeated operations, burnishing, etc., the drop-out ration may fall below 90%. If this occurs, the plunger steel should be screwed own to compensate for the change in the contact gap. However, if the plunger steel is changed, the relay must be recalibrated. The following procedure should be used to recalibrate the relay.

Set the core screw at ten turns up from its bottom position. Adjust the plunger steel position on the plunger until the current value at which the plunger drop-out is 90% of the maximum rated current. Then set the contact gap at 3/4 of a turn down, and adjust the core screw for pick-up. Drop-out value will be above 90% at this setting. If desired, the contact gap and follow may be increased by lowering the contact shield and readjusting the core screw for pick-up.

8.2 CONTACTOR SWITCH

Turn the relay up-side-down. Screw up the core screw until the contact ring starts rotating. Now back off the core until the contact ring stops rotating. Back off the core screw one more turn and lock into place. Adjust the two nuts at the bottom of the switch so that there is a 3/32 inch clearance between the moving contact ring and the stationary contacts in the open position. The guide rod may be used as a scale as it has 52 threads per inch, therefore, 5 turns of the nut will equal approximately 3/32 inch. The contactor switch is a dc operated switch with a pick-up of 2.0 amperes.

8.3 OPERATION INDICATOR

Close the main relay contacts and pass 95% of rated indictor current dc through the trip circuit. Adjust the operation indicator by moving the flag holder such that the indicator operates with the applicaiton of the 95% curent.

8.4 TELEPHONE TYPE RELAY ADJUSTMENT

Adjust the armature gap on the telephone type relay to be approximately .004 inch with the armature closed. This done with the armature set-screw and lock-nut. also, adjust contact leaf springs to obtain at least .015 inch gap on all contacts and at least .005 inch follow on all normally closed contacts.

8.5 RHEOSTAT KNOB ADJUSTMENT, SAME SCALE PLATE

If it is necessary to replace the rheostat (P1) or the silicon power regulator (Z1), the relay may be recalibrated with the same scale plate, in most cases. This is done by rotating the rheostat shaft, without know, until a time delay equal to the minimum scale marking is obtained. Then, align the knob for this delay and tighten the know set-screw securely. Pause several seconds between readings for all delays above .05 seconds. See section under Accuracy for this discussion.

8.6 SCALE PLATE CALIBRATION, NEW SCALE PLATE

If it is necessary to replace the potentiometer (p2) or the printed circuit, the relay should be recalibrated with a new scale plate. Use the following procedure:

a) With the knob off the shaft, set the rheostat (P1) at maximum.

b) Adjust (P2) so that the times are 5% to 10% longer than the maximum scale marking.

c) Set the rheostat (P1) at minimum and check that times are less than or equal to the minimum scale marking. If not, adjust P2 slightly to reduce times. Tighten lock nut on P2.

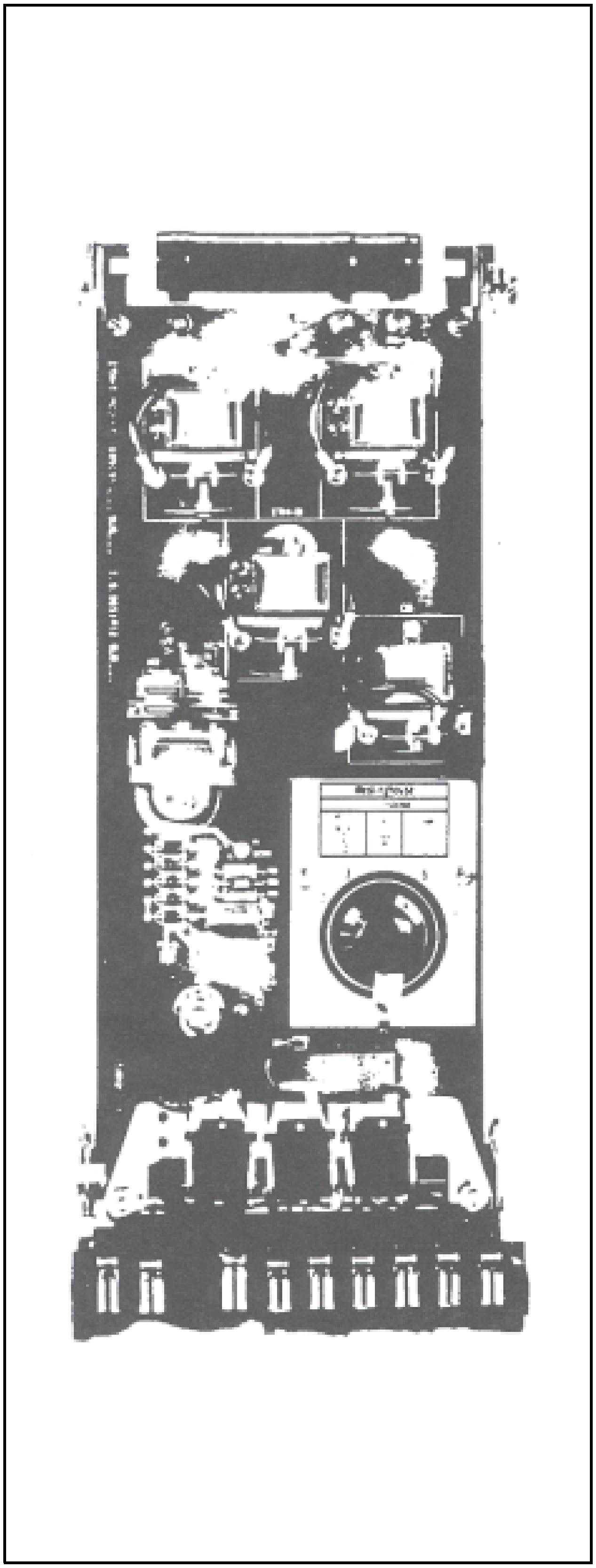
d) Place the knob on the rheostat shaft in such a position that the times are symmetrical with respect to the scale plate markings. Tighten the knob set-screw and mark calibration lines on the scale plate. When striking calibration lines for delays above 0.5 seconds, pause at least 3 seconds between readings. See action under Accuracy for discussion of this.

9.0 INSTALLATION

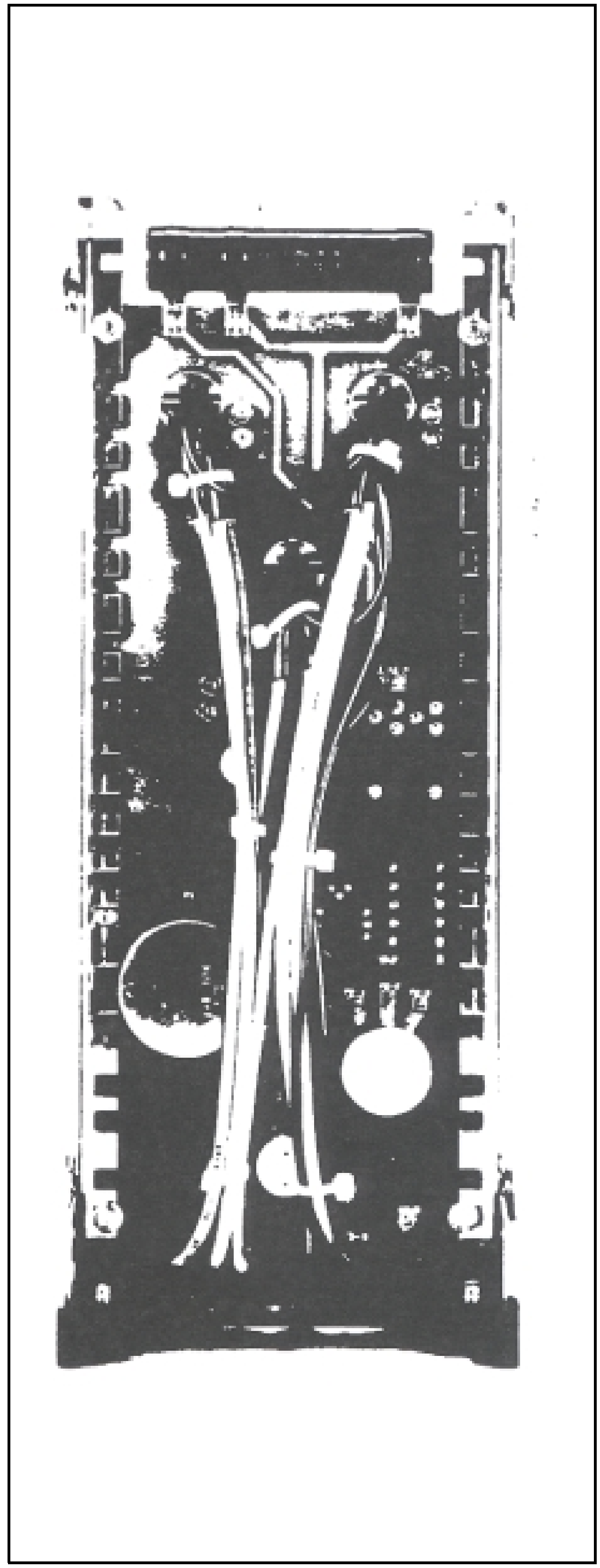
The relay should be mounted on switchboard panels or their equivalents in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the rear mounting stud or studs for the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either the stud or the mounting screws may be utilized for grounding the relay. External toothed washers are provided for use in the locations shown on the outlilne and drilling plan to facilitate making a good electrical connection between the relay case, its mounting screws or studs, and the relay panel. Ground wires are affixed to the mounting screws or studs as required for poorly grounded or insulating panels. Other electrical connections may be made directly to the terminals by means of screws for steel panel mounting or to the terminal stud furnished with the relay for thick panel mounting. The terminal stud may be easily removed or inserted by locking two nuts on the stud and then turning the proper nut with a wrench.

For detail information on the FT case refer to I.L. 41-076.

LIST OF FIGURES



ITH-T Relay, Front View



ITH-T Relay, Rear View

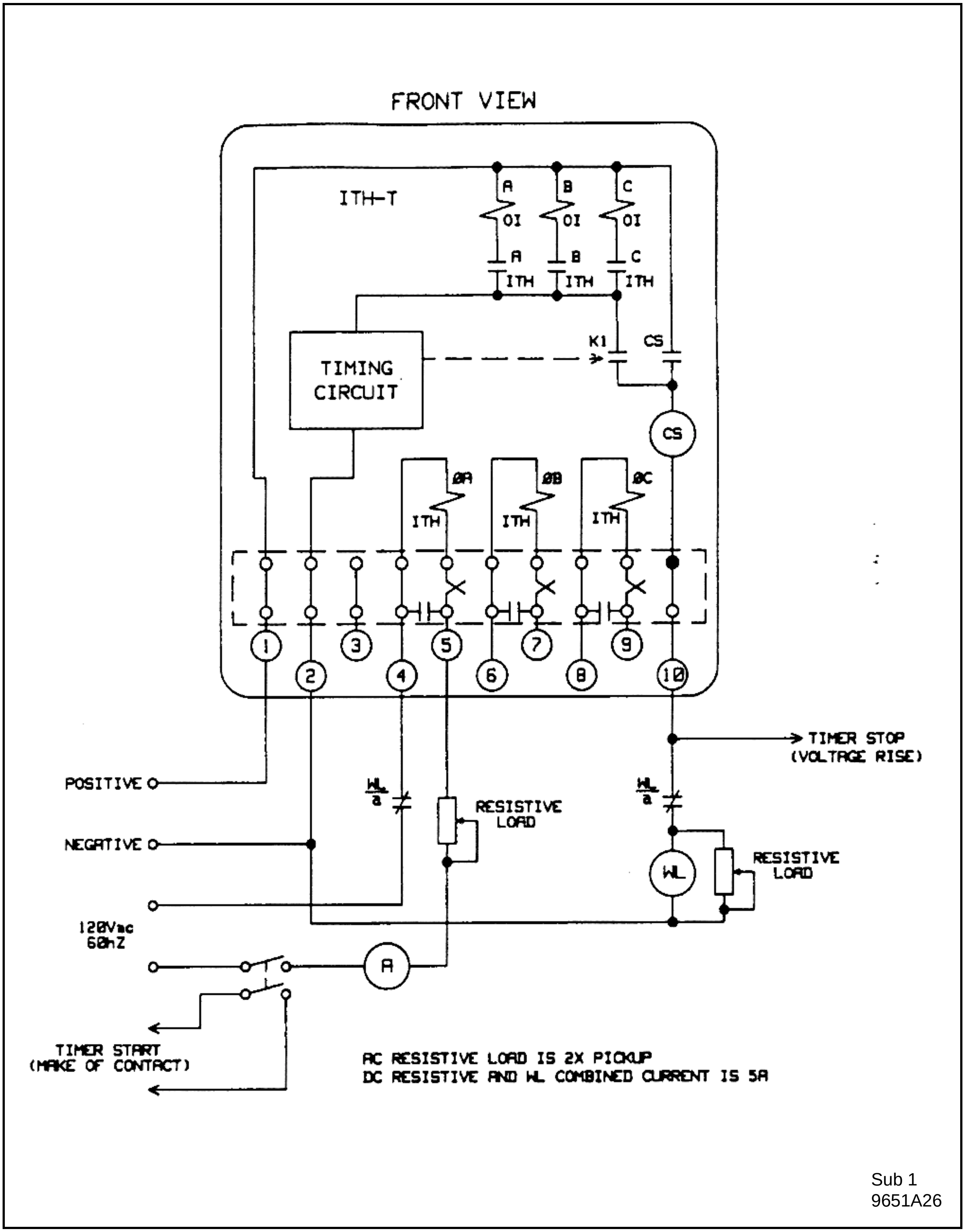


Figure 1: Test Circuit

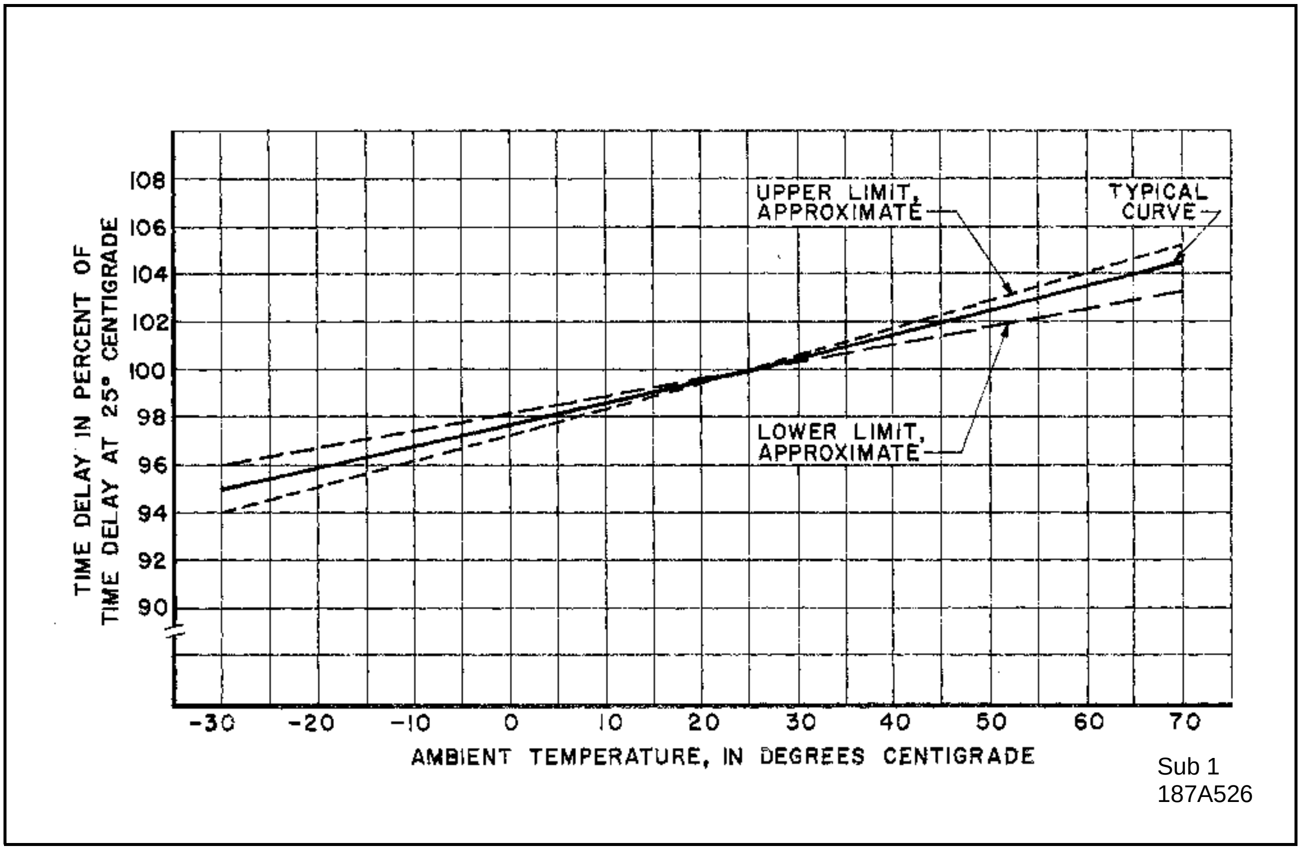


Figure 2: Typical Time Delay Variation with Termperature

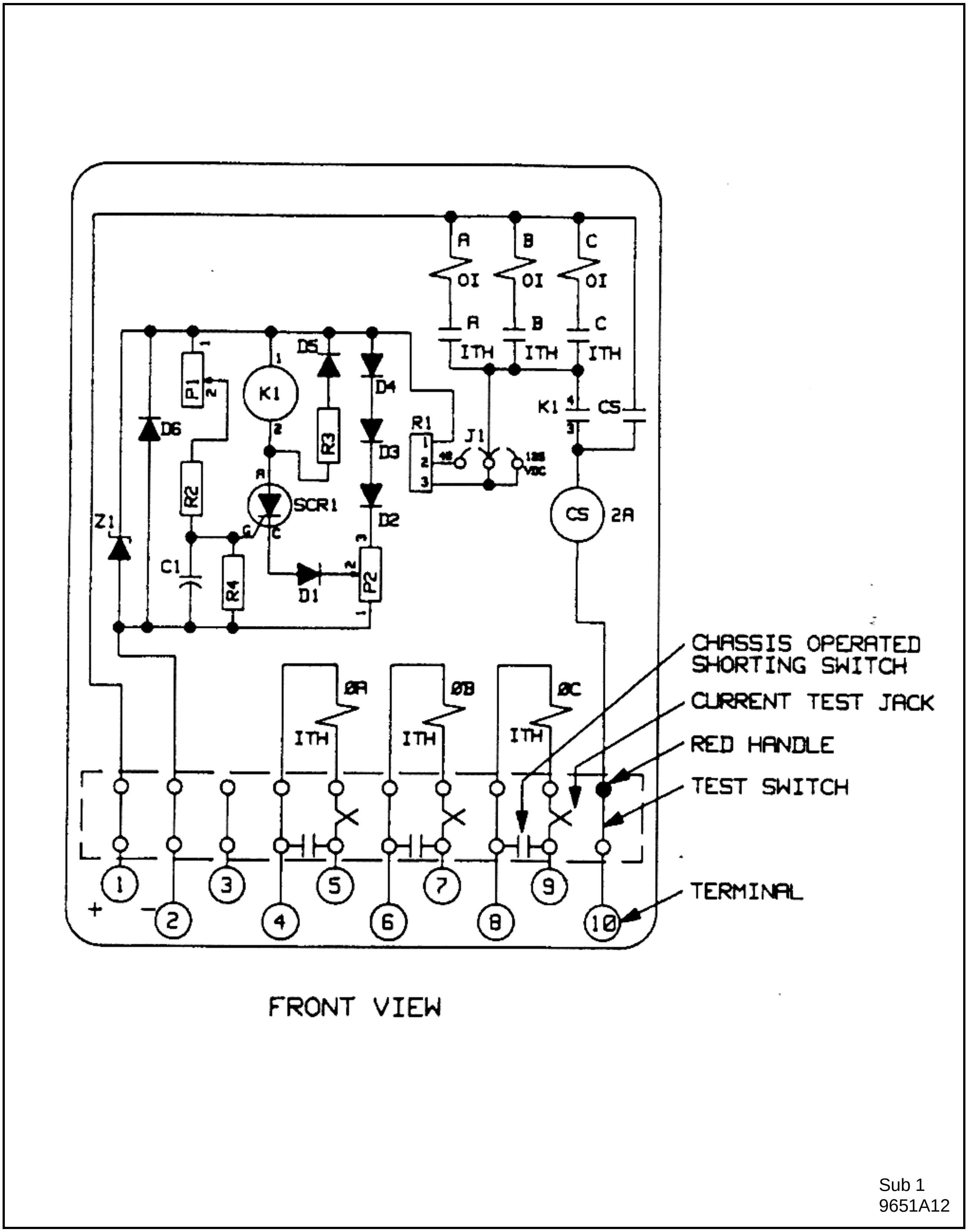


Figure 3: ITH-T Internal Schematic

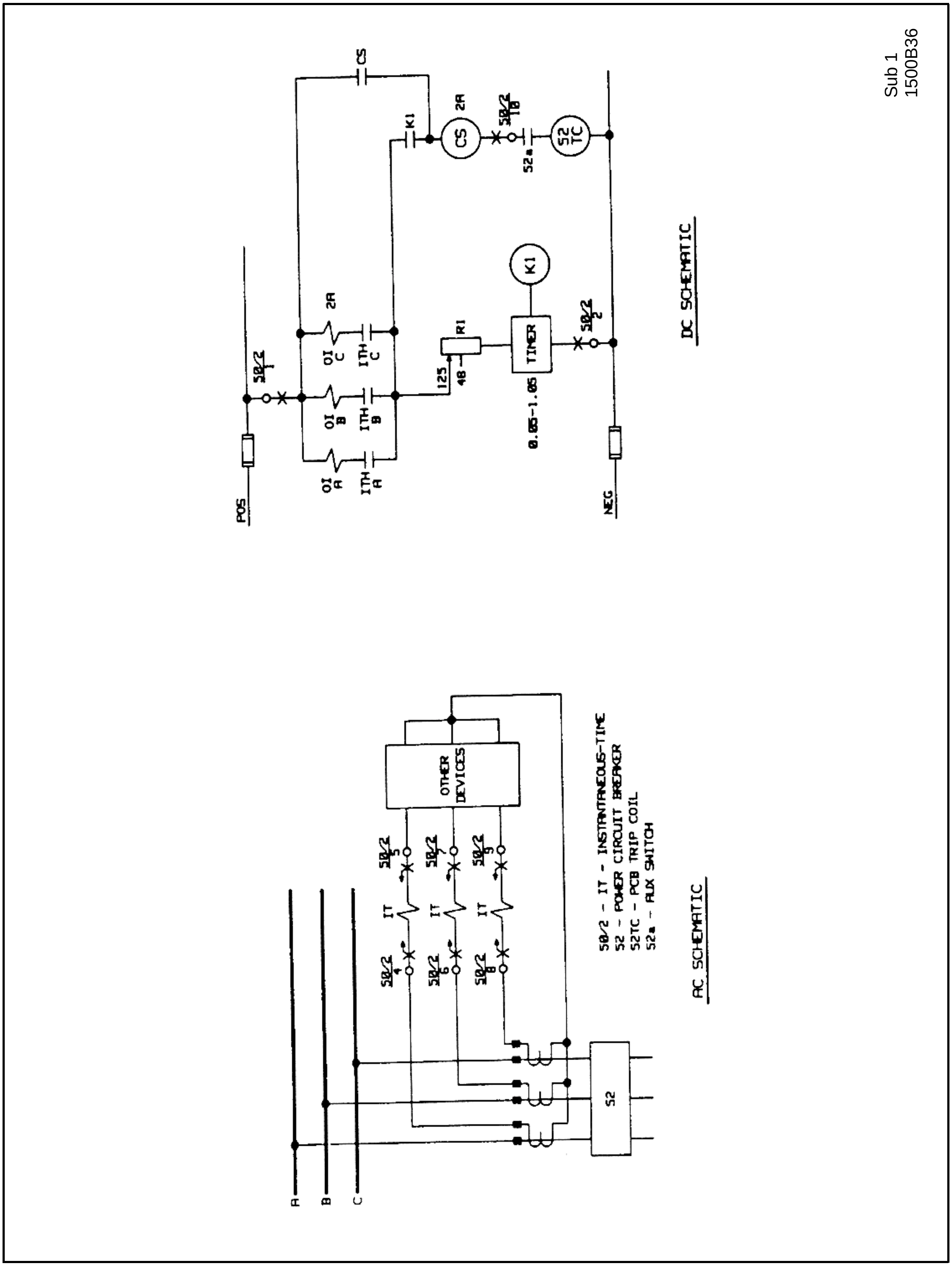


Figure 4: ITH-T External Schematic

IL 41-771.2 - Revision December, 1989

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