



F E D E R A L P I O N E E R L I M I T E D

19 WATERMAN AVENUE TORONTO ONTARIO M4B 1Y2 • 759-5651

C-4-905-1

INSTRUCTION MANUAL

FOR TESTING OF TYPE TLR AND ILR RELAYS

WITH TYPE DDT-TLR TEST SET

JANUARY 1980



INDEX

- A. INTRODUCTION
- B. TESTING PROCEDURE
 - B1 Pick-up Test
 - B2 "Restraint-Out" Test
 - B3 Time Test
 - B4 Restraint Test
 - B5 Transmitter Unit
- C. SYSTEM COORDINATION TESTING
 - C1 Restraint Continuity Test
 - C2 Sensor Wiring Continuity Test
 - C3 Coordination Tests

FOR TESTING OF TYPE TLR AND ILR RELAYS
WITH TYPE DDT-TLR TEST SET

December 1979

A. INTRODUCTION

All solid state relays are sensitive to source impedance, and perform best when tested under exact operating conditions. That is, testing by full current primary injection with a single conductor through the sensor window. Needless to say, this becomes impractical in field testing, where, for example a 2000 amp relay setting is to be checked at eight times pick-up. Because of the high impedance characteristic of the TLR relay and sensor combination, reliable field testing may be accomplished by secondary voltage injection, with the sensor remaining in circuit.

The TLR Test Unit has been designed for this purpose, and is to be recommended for field testing. It is portable and compact and tests not only all basic functions of the relays and transmitters, but can perform a complete system test with all relays energized simultaneously. Interconnection of restraint lines between the zones can be quickly checked.

The Test Unit includes an electronic memory type time indicator, which gives accurate timing with no actual connection to the relay trip contacts, as would be required with a conventional time indicator. This indicator senses the "shorting" action of the relay, which occurs at the exact instant of trip. A complete relay operation can be performed in the field without disconnecting any wiring and without withdrawing the relay from its case. A time test feature is included to check the integrity of the time indicator.

Fig.1 shows the Test Unit panel layout, and Table 1 gives test settings for the various relays. It should be noted, that all voltage data has been established on the basis of actual response of each relay under its normal operating conditions, with single turn primary current through the sensor window. The Test Unit includes a set of test cables, listed on Fig.3.

B. TESTING PROCEDURE

All drawout models of the TLR relay are equipped with a lockout switch operated by the left-hand cradle latch. Opening of this latch can be used to disconnect control to a breaker shunt trip in cases where it is not desired to actually trip the breaker during the test.

B1. PICK UP TEST

1. Remove the relay front cover (drawout and surface mounting models) and remove the rating on the faceplate to expose the test socket. Plug in test cable.
2. Plug the Test Unit into a source of 115-120 volts a.c.

3. Set the TEST switch to the PICK-UP region and to the position corresponding to the relay to be tested.
4. Set the METER switch to PICK-UP and TIME.
5. For a TLR-1, set the relay time band selector to instantaneous.
For a TLR-2, set the Test Unit RESTRAINT IN switch to OFF.
For a TLR-3, set the relay mode selector switch to ZSIP and set the Test Unit RESTRAINT IN switch to OFF.
This places each type of relays in instantaneous operating mode.
(ILR relays are inherently instantaneous.)
6. Set the relay PICK-UP selector to the middle setting.
7. Press the Test Unit ON button.
8. Holding the RUN switch closed; slowly increase the voltage from zero, noting the point at which the relay trips and compare to the data sheet, Table 1. (In any pick-up test, it is important that the signal be increased slowly so as to not exceed the meter damping response.)
9. Any deviation in excess of 5% should be corrected by adjusting the TRIM control on the relay faceplate. (Fig. 2)
10. Test the low and high pick-up points in the same manner. No further trim is provided for these ranges, because they are controlled by a simple switching of additional shunt resistors.

B2. RESTRAINT OUT

At this point, the relay should be tested for its outgoing restraint signal.

11. Turn the Test Unit METER switch to RESTRAINT OUT and repeat any one of the pick-up tests.
12. Note the meter reading and compare to the data sheet. It should be noted that, in this position, the meter is indicating d.c. volts and the scale is 0 - 30 or a 10:1 divider. It is not necessary to test all three pick-up points because once pick-up has been confirmed, all three will produce the same restraint voltage.

NOTE:

This indicating element of the TLR Test Unit may be used in normal system operation to detect presence of ground current at levels below pick-up.

With the Test Unit disconnected from the power supply, plug the main cable into the relay socket as in routine relay tests, and turn the Test Unit METER switch to RESTRAINT OUT. The meter will now indicate ground current signal being received by the relay from its sensor. As in the foregoing "Restraint Out" test, the meter scale is 0 - 30 volts.

FOR TESTING OF TYPE TLR AND ILR RELAYS
 WITH TYPE DDT-TLR TEST SET

December 1979

Relay pick-up will be reached at approximately 20 volts on this reading, and the scaling is linear with respect to actual ground current, e.g. at 10 volts the ground current is one-half the value of the relay pick-up setting. This holds true for all relay types and all pick-up settings.

B3. TIME TEST

This is the most important function of the relay in system coordination, and the most important area is the short time portion of the three bands. Most system faults will fall in this region. A total of only three check points are charted, because these are adequate to confirm the inverse time characteristic. All three time bands should be checked, but again, as in the restraint test (Item 12), it is not necessary to test at all three pick-up settings. Design of the TLR relay is such that, for each pick-up setting, the same multiple of that setting will produce the same signal to the timing stage.

All TLR relays have a "shorting action" at tripout, and this action is very necessary to reset the relay in cases where field tests must be made on a live system which is under load, and which may have (as most systems do) varying degrees of so called "nuisance leakage signals". However, this shorting action does, in effect, subject the test device to a "bolted fault", the instant the relay trips. To protect itself, therefore, the TLR Test Unit trips out after each time test run, and must, each time, be reset by again pressing the ON button.

1. Turn Test Unit TEST switch to TIME, and the METER switch to PICK-UP and TIME.
2. Turn relay TIME selector to 0.1 second and PICK-UP to the middle setting.
3. For a TLR-2, set the Test Unit RESTRAINT IN switch to TIME.
For a TLR3, set the relay mode selector switch to TCP and the Test Unit RESTRAINT IN switch to TIME.
4. Check the Test Unit time indicator by operating TEST-RESET switch. The "0.4 sec." indication should be observed on both the X1 and X2 scales. Return the SCALE switch to X1. RESET must be used after each time reading to clear the meter, and the switch should be held in RESET for a second or two to completely erase. Tripout of the drive portion of the unit when resetting the time indicator is normal and intentional. Its significance will appear later in the blocking test.

5. With the RUN switch open, set voltage to the value as shown on the data sheet, Table 1.
6. Close the RUN switch, note the time to trip, and compare to the data sheet. It should be noted that these voltage values are based on an open circuit setting, and the "droop" in the meter reading when the test run begins is normal and is taken into account. Do not readjust to compensate for this condition. As the data sheet will suggest, time readings for the 0.1 sec. and 0.2 sec. relay time band settings can best be read with the Test Unit TIME BAND switch set at X1. For tests on the 0.4 sec. range, use the X2 setting.
7. Any deviation in excess of 10% should be corrected, but again, it will be repeated that the important region is the short time part of the band. If correction is necessary, it should be done only after making all three tests on any one time band, and any adjustment should be made on the 0.4 sec. band.
8. Time adjustment is provided by a trim potentiometer on the printed circuit board assembly within the relay. For drawout models, it is necessary to withdraw the cradle from the case. Open the remaining right-hand cradle latch to withdraw the unit. Shorting contacts in the relay case close the c.t. secondary circuit and the relay may now be bench tested with the Test Unit plug in the faceplate socket as before. For surface mounting and semi-flush mounting relays, the back cover has to be removed in order to gain access to the trimming potentiometer. Therefore, this adjustment should not be performed when the relay is energized in the system.
9. Adjust the time control as required to conform to the data sheet. Turning the trimmer clockwise will increase the time, counter-clockwise will decrease the time. If extensive adjustment appears necessary, the matter should be reported to the factory.

B4. RESTRAINT TESTS (TLR2 and TLR3)

The time restraint function of any TLR-2 or TLR-3 relay will have been confirmed in performance of the foregoing time tests. The sequence now outline is necessary to test operation of the blocking restraint element.

1. Set the relay PICK-UP selector to the low position, and the TIME selector to 0.1 second.
2. Turn the Test Unit TEST switch to TIME, and the METER switch to PICK-UP and TIME. With the RUN switch open, set the voltage to the "0.125 second" setting as listed in the Test Data Table.



FOR TESTING OF TYPE TLR AND ILR RELAYS
WITH TYPE DDT-TLR TEST SET

December 1979

3. Turn Test Unit RESTRAINT IN switch to BLOCK.
4. Turn the Test Unit Time Band switch to X10 (5 seconds).
5. Turn the RUN switch on, and hold until the Test Unit trips out. The relay under test should not trip, confirming that the blocking restraint element is functioning as it should.

B5 TRANSMITTER UNIT

Testing of the Transmitter Unit consists of observing "restraint out" signal as in the TLR relay. Swing aside the rating plate and insert the Test Unit plug as before. The Unit has a response characteristic similar to a TLR 100, operating at its 100 amp. pick-up setting.

1. Set the Test Unit TEST switch to PICK-UP TLR100 and 1000.
2. Set the Test Unit METER switch to PICK-UP and TIME and press the ON button.
3. Hold the RUN switch on, and increase the voltage to 60, as shown in Table 1.
4. While holding this voltage setting, turn the METER switch to RESTRAINT OUT.
5. Note the meter reading and compare the results to data in Table 2.

C. SYSTEM COORDINATION TESTING

The TLR Test Unit may be used to perform a complete ZSIP System coordination test. In this procedure, all zones which would be carrying the ground fault receive signal simultaneously, as is the case in actual practice. Similarly, when the relay under direct observation trips, the signal disappears in all zones. This corresponds to normal operation where the appropriate breaker has cleared the fault. Block restraint may be injected into a zone to simulate the condition where a breaker has failed to clear the fault, and where the back-up zone ahead must then operate.

The test is a parallel condition all relays concerned and injection of the signal into the system can be made at the various relay faceplate test sockets, as in the normal relay test. In installations where the "send" and "receive" points are widely separated, adapters can be employed to permit use of the power bus bars as a transmission line, provided the bus can be de-energized and all loads opened during the test period.

One of the features of the TLR relay design is the fact that all ranges of pick-up operate at a similar voltage level, regardless of the full load area of the system, size of the sensor, or pick-up level in the coordination pattern. This is quite unlike the conventional current driven protective relay which would require complex "series injection" to simulate operating conditions. Significance of this characteristic lies in the fact that the ZSIP SYSTEM COORDINATION TEST herein described places all relays (or zones) in the active area of operation. That is to say, coordination is simulated in its most critical

state, where all zones are subjected to the equivalent of a major system fault. In many instances, a fault current would not reach the pick-up level of upstream zones, and coordination would then follow the conventional cascade pattern. However, in present day high capacity systems, it is more possible that the fault level would reach several multiples of pick-up in all zones. The individual relay pick-up tests, as outlined in Items 1 to 10, will have confirmed cascade coordination, and the following procedure will, therefore, be devoted to testing for time coordination.

The TLR Test Unit is fitted with one test cable, attached to the unit at the left-hand end of the case, and this will be referred to as the "main" cable. This fitting is used alone in the foregoing tests for individual relay operation. For the system tests to follow, three additional cables are supplied, referred to as "coupler" cables. These are served by three polarized sockets located in the right-hand end of the cabinet, and are used to apply ground fault signal simultaneously to three other relays or zones. The coupler cables terminate in a male plug similar to the main cable, and are normally inserted in the faceplate socket of the other relays.

C1. RESTRAINT CONTINUITY TEST

In a complete system test, the first operation should be that of ensuring that restraint lines between zones are continuous, not shorted together, and are connected to the proper relays, and to the intended restraint element (i.e., time or block). With reference to Fig. 4, it will be seen that the test is made between each two adjoining zones, with the TEST UNIT located at the upstream or "receiver" zone. Proceed as follows:

1. Plug the main test cable into the relay at the intended "receiver" location.
2. Plug one coupler cable into the relay at the intended "sender" location.
3. Set the TEST UNIT switches as follows:

RESTRAINT IN - to off

METER - to PICK-UP AND TIME

TEST - to PICK-UP and to suit the downstream relay under test.

4. Press the ON button, and set the test voltage to 100 volts.
5. Turn the METER switch to CONTINUITY and press the RUN switch.
6. Turn the CONTINUITY selector toggle switch to T or B* as required for the installation, and observe the meter indication. See Table 2. (The meter is now operating 0 - 30 volts d.c., as in the Restraint Out Test, Items 11 and 12.

This indication will vary, depending on the various relay ranges being used, and it should be noted that this is not required to be a close tolerance observation. Output restraint values will have been previously confirmed in Test Procedure, Items 11 and 12. The purpose of this

FOR TESTING OF TYPE TLR AND ILR RELAYS
WITH TYPE DDT-TLR TEST SET

December 1979

test is to confirm that the sender relay is connected to the correct receiver relay, and to the correct terminal of that relay. The suggested value of test voltage is purposely below pick-up of the lowest range relay - it is intended that no relay trips out during this test. In no case should voltage appear on T and B from any one sender. However, in some installations, one sender may restrain more than one upstream zone, and here each pair must be tested separately, (eg., zone 4 to zone 3, then zone 4 to zone 2).

Many installations will have several senders in the one zone, all restraining one upstream zone (eg., feeders to main). Each feeder to main combination should be tested separately, with the main acting as receiver, and each feeder in turn acting as sender.

Typical double-ended systems employing "main-tie-main" breaker arrangements usually require that feeder restraint from one side of the system appear at the tie breaker relay and at the main breaker relay associated with that side of the system, but must not appear at the other main breaker relay. Restraint Continuity Test should be used to confirm this point also.

As indicated in Table 2, it will be seen that all relays are set at the low pick-up point for this test. For installations employing TR-1 transmitters, this unit is treated the same as a TLR 100 acting as sender.

C2. SENSOR WIRING CONTINUITY

At factory final inspection, or at least prior to initial start up, it is advisable to confirm interconnecting wiring between sensor and relay. An adapter fitting for the main cable and a socket adapter terminating in two alligator clips are supplied with the TLR Test Unit. The procedure is simply that of injecting the signal at the sensor terminals, rather than at the face-plate socket. The observation is that of confirming that a signal level is obtained at the relay.

For ILR-25,-100 and TLR-25,-100,-500, TLR-3-25,-100 and -500, connect the sensor cable to the sensor secondary terminals. Follow the pick-up test procedure as described under Pick-up Tests. Test Set connection are shown in Fig. 5.

For TLR-A-1000,-2000, and TLR-3-1000 relays it is necessary to use the "special auxiliary cable" between the relay test socket and the test set main output cable. Plug the special auxiliary cable into the relay test socket and connect the auxiliary sensor cable to the sensor "sec" terminals, as shown in Fig. 6.

1. Turn the test switch to "TLR-100 and 1000". Set the voltmeter reading at 115V on the test set for TLR-A-1000, TLR-3-1000 and at 230V for TLR-A-2000.
2. Set the relay to its lowest pick-up position.
3. Turn the meter switch to "Restraint Out".

Press the "Run" button. The meter should read about 5 volts on 30V scale.

C3. COORDINATION TEST

In this test, all relays are successively tripped, to simulate actual operating conditions. If the system is on load it will be necessary to deactivate the breaker trip circuits to avoid interrupting service, and this can be done quite readily in the drawout style TLR by opening the left-hand cradle latch. The surface and the semiflush mounted unit will require disconnecting the trip circuit. Whenever possible, at least one breaker trip should be performed before terminating the test to ensure that the breaker trip circuit is operating.

Fig. 7 shows a typical 4-zone system, and it will be seen that the procedure is one of beginning at the extreme downstream zone, and moving progressively up to the first zone. Again, as in the foregoing Restraint Continuity Test, this is not an accuracy test - it is an operation test, and the time data shown is only approximate. Different relay range settings will produce different time indications, because of varying burden to the Test Unit. The important observation is to confirm that the various relays function as indicated.

First Step

1. Plug the main cable into the relay at zone 4, and the coupler cables into relays at zone 3, zone 2 and zone 1.
2. Set the Test Unit switches as follows:

RESTRAINT IN	- to OFF
METER	- to PICK-UP and TIME
TEST	- to TIME ALL TYPES
TIME SCALE	- to X2
3. Press the ON button and set the test voltage to 100 volts.
4. Press the RUN switch and observe that zone 4 relays trips instantly, and all others hold.

Second Step

5. Move the main cable from the zone 4 relay to zone 3 relay, with coupler cables to zone 2 and zone 1.
6. Set the Test Unit RESTRAINT IN switch to TIME and repeat the test.
7. Zone 3 relay should now trip at approximately the time shown on the chart. Zones 2 and 1 should hold. This confirms that time restraint is operating, and simulates the back-up action of zone 3 should zone 4 fail to clear.
8. Turn the Test Unit RESTRAINT IN switch to OFF and repeat the test.
9. Zone 3 relay should now trip instantly and zones 2 and 1 should hold. This has simulated a fault occurring in zone 3.
10. Turn the Test Unit RESTRAINT IN switch to BLOCK and repeat the test.
11. Zone 3 relay should now hold, and zone 2 relay should trip at approximately the time shown on the chart. Zone 1 relay should hold. This has confirmed back-up action of zone 2 should zone 3 fail to clear.

FOR TESTING OF TYPE TLR AND ILR RELAYS
WITH TYPE DDT-TLR TEST SET

December 1979

Third Step

12. Move the main cable from the zone 3 relay to zone 2 relay, with one coupler cable to zone 1.
13. Turn the Test Unit RESTRAINT IN switch to OFF, and repeat the test.
14. Zone 2 relay should trip instantly, and zone 1 should hold. This has simulated a fault occurring in zone 2.
15. Turn the Test Unit RESTRAINT IN switch to BLOCK, and repeat the test. Zone 2 relay should hold and zone 1 relay trip at approximately the time shown on the chart. This simulates the condition where zone 2 has failed to clear.

Fourth Step

16. Remove the remaining coupler cable, and plug the main cable into zone 1 relay.
17. Turn the Test Unit RESTRAINT IN switch to OFF and repeat the test.
18. Zone 1 relay should trip instantly, simulating a fault in zone 1.

It is important to note that in installations using blocking restraint, only the zone or zones which are receiving the block signal can be observed under normal operating condition. For example, a typical 3-zone system of this nature would be one which uses a TR1 Transmitter in zone 3. Restraint signal from this point would be fed into the zone 2 relay ahead as a block. The zone 2 relay in turn sends a time restraint signal to the zone 1 relay. When test signal is now injected into all three zones, the zone 2 relay will not trip, (confirming block from zone 3) and the zone 1 relay will time trip (confirming time restraint from zone 2).

In actual practice zone 1 will not trip because branch circuit devices in zone 3 will have cleared the fault before it has reached the pick-up level of zone 1, and this will have been established in the initial design of the installation. Pick-up tests, Items 1 to 10, made on the zone 1 relay will have confirmed that its pick-up point is properly above the response of the zone 3 branch circuit device. This test does, however, demonstrate the back-up protection of zone 1 should zone 3 fail to clear entirely.



FOR TESTING OF TYPE TLR AND ILR RELAYS
WITH TYPE DDT-TLR TEST SET

JANUARY 1980

TABLE 1

Relay	Test Set Settings	Pick Up	0.1 Second Band			0.2 Second Band			0.4 Second Band			0.6 Second Band		
			0.2	0.125	1.0	0.4	0.25	0.2	0.8	0.5	0.4	1.2	.75	0.6
ILR-25	25	62												
	50	115												
	100	230												
ILR-100	100	57												
	250	125												
	500	230												
TLR-A-25 TLR-3-25	25	70												
	50	115	(3.3) 70	(5.4) 110	(10) 230	(3.3) 70	(5.4) 110	(10) 230	(3.3) 70	(5.4) 110	230(10)			
	100	210												
TLR-A-100 TLR-3-100	100	60												
	250	130	(3.3) 85	(5.4) 140	240(10)	(3.3) 85	(5.4) 140	(10) 240	(3.3) 85	(5.4) 140	240(10)			
	500	230												
TLR-A-500 TLR-3-500	500	100												
	750	140	(3.3) 130	(5.4) 185	250(10)	(3.3) 130	(5.4) 185	(10) 250	(3.3) 130	(5.4) 185	250(10)			
	1000	175												
TLR-1000	1000	90												
	1500	120	(3.3) 85	(5.4) 130	260(10)	(3.3) 85	(5.4) 130	(10) 260	(3.3) 85	(5.4) 130	260(10)			
	2000	155												
TLR-A-1000 TLR-3-1000	1000	110												
	1500	147	(3.3) 90	(5.4) 145	260(10)	(3.3) 90	(5.4) 145	(10) 260	(3.3) 90	(5.4) 145	260(10)			
	2000	185												
TLR-2000	2000	155												
	2500	180	(3.3) 100	(5.4) 160	260(10)	(3.3) 100	(5.4) 160	(10) 260	(3.3) 100	(5.4) 160	260(10)	150(3.3)	160(5.4)	260(10)
	3000	210												
TLR-A-2000	2000	190												
	2500	227				(3.3) 110	(5.4) 165	260(10)	(3.3) 110	(5.4) 165	(10) 260	110(3.3)	165(5.4)	260(10)
	3000	115												

- NOTES:**
1. For pick-up - rate voltage slowly.
 2. For time - preset to values of A.C. volts shown, then close "RUN" switch.
 3. Restraint out - 20 to 28 volts at pick-up.
 4. On earlier production units the time bands are marked in cycles based on 60Hz. Markings 6-12-24 cycles correspond to 0.1 - 0.2 - 0.4 seconds.
 5. () Equivalent current level at multiples of PICKUP.

RESTRAINT CONTINUITY

Relay Pick Up - Amps		Restraint Volts At Receiver	Test Unit "Test Switch Set at
Sender	Receiver		
25	100	6.0 Volts	Pick Up TLR 25 & ILR
100	500	6.0 Volts	Pick Up TLR 100 & ILR, TLR 1000
500	1000	13.8 Volts	Pick Up TLR 500

FOR ALL ABOVE SET TEST VOLTS AT 100

TABLE 2



FOR TESTING OF TYPE TLR AND ILR RELAYS
WITH TYPE DDT-TLR TEST SET

JANUARY 1980

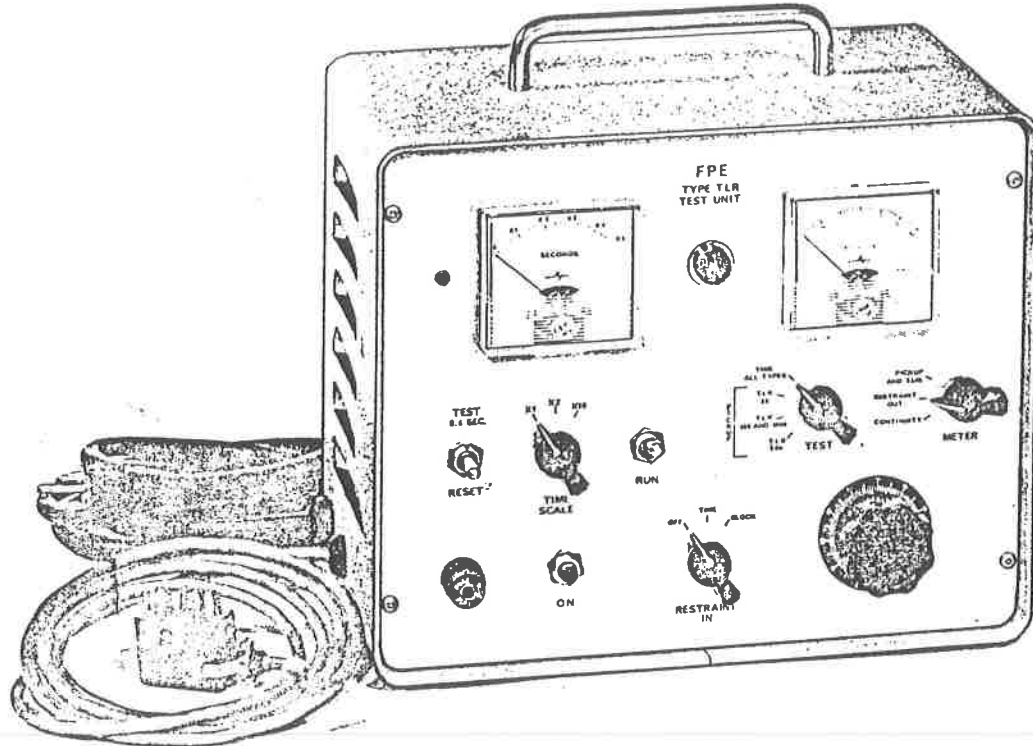


FIG. 1

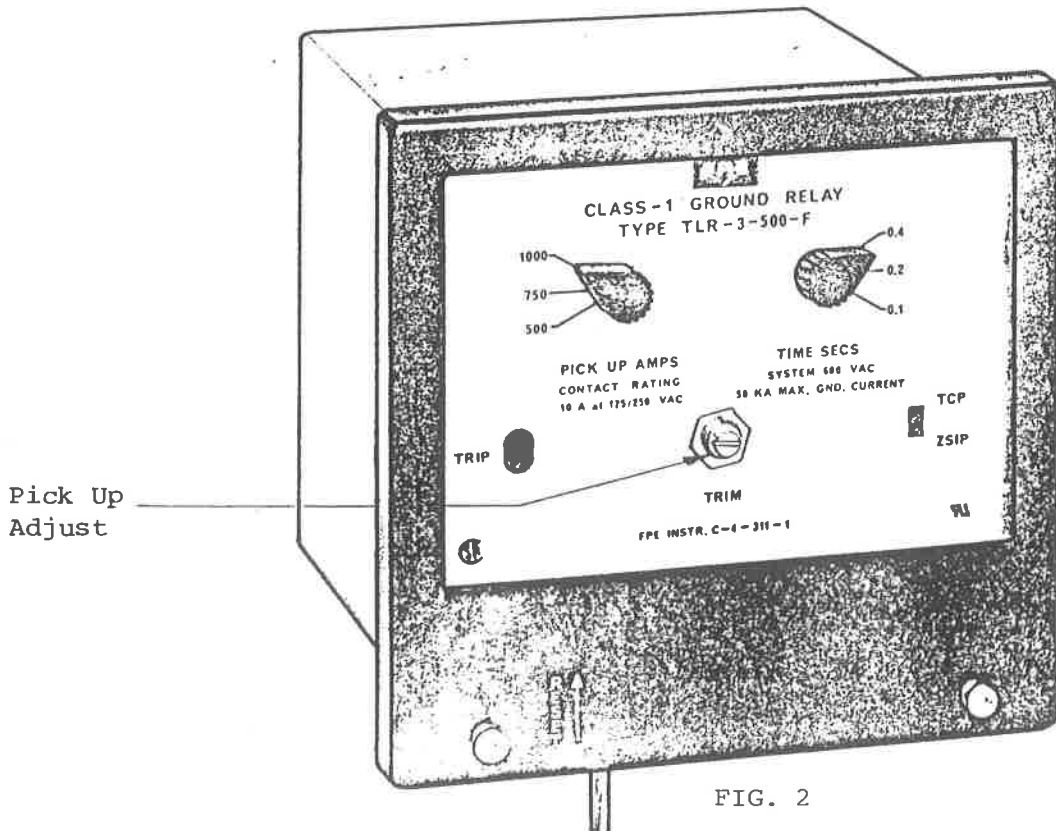


FIG. 2



TEST CABLES

COUPLER CABLE

PART NO. 197 - 001W

(USED IN SYSTEM CO - ORDINATION TESTING)



SENSOR CABLE

PART NO. 197 - 002W

(USED FOR SENSOR WIRING CONTINUITY CHECK)



AUXILIARY SENSOR CABLE

PART NO. 197 - 003W

(USED FOR SENSOR WIRING CONTINUITY CHECK
AND TO FEED SIGNAL TO SENSOR TERMINALS)



EXTENSION CABLE (MULTI - CONDUCTOR)

PART NO. 197 - 005W

(USED FOR EXTENDING MAIN CABLE)



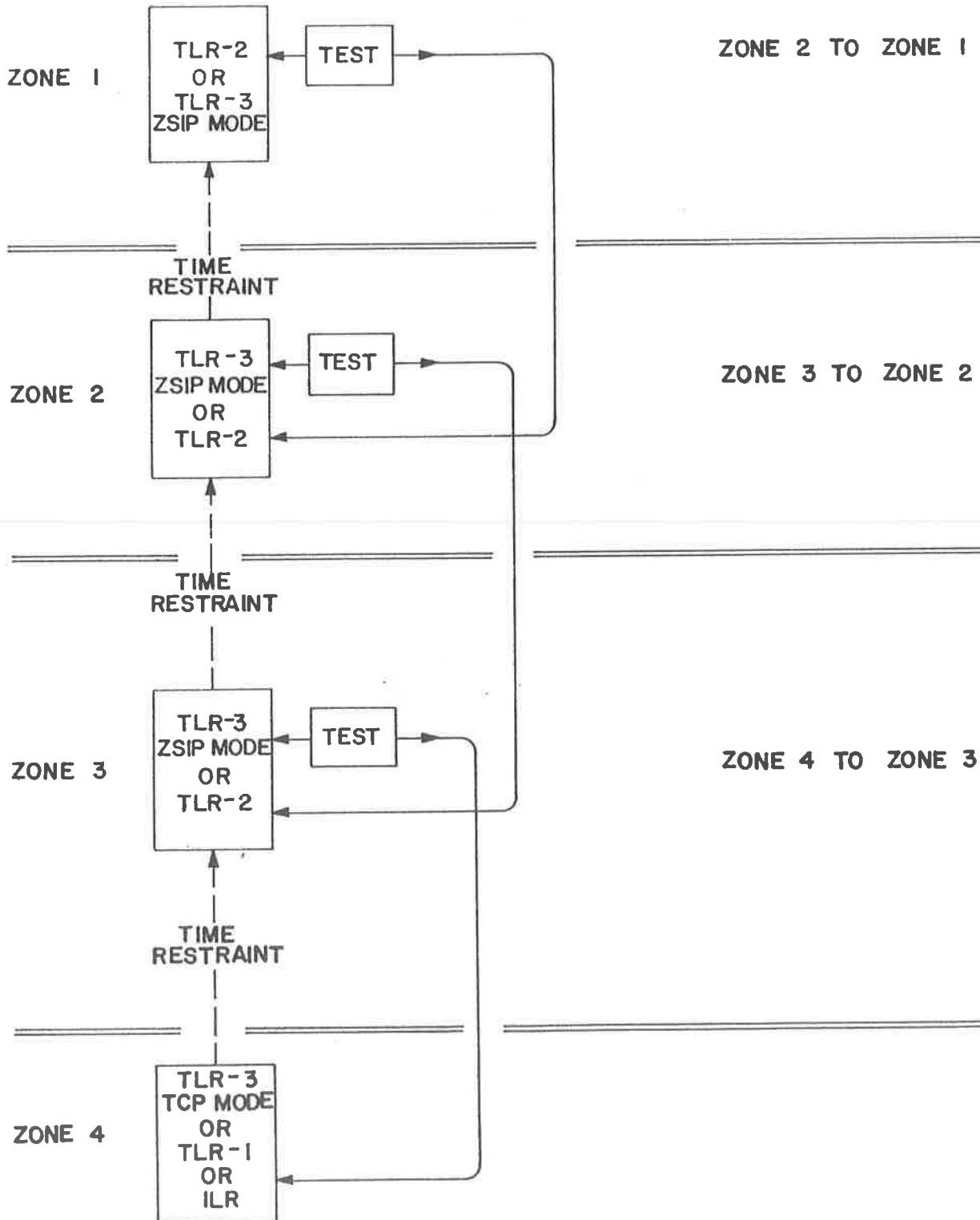
SPECIAL AUXILIARY CABLE

PART NO. 197 - 006W

USED FOR CONTINUITY CHECK FROM SENSOR
TO RELAY IN TLR - A - 1000 & TLR - A - 2000
TLR - 3 - 1000 & TLR - 3 - 2000



FIG. 3

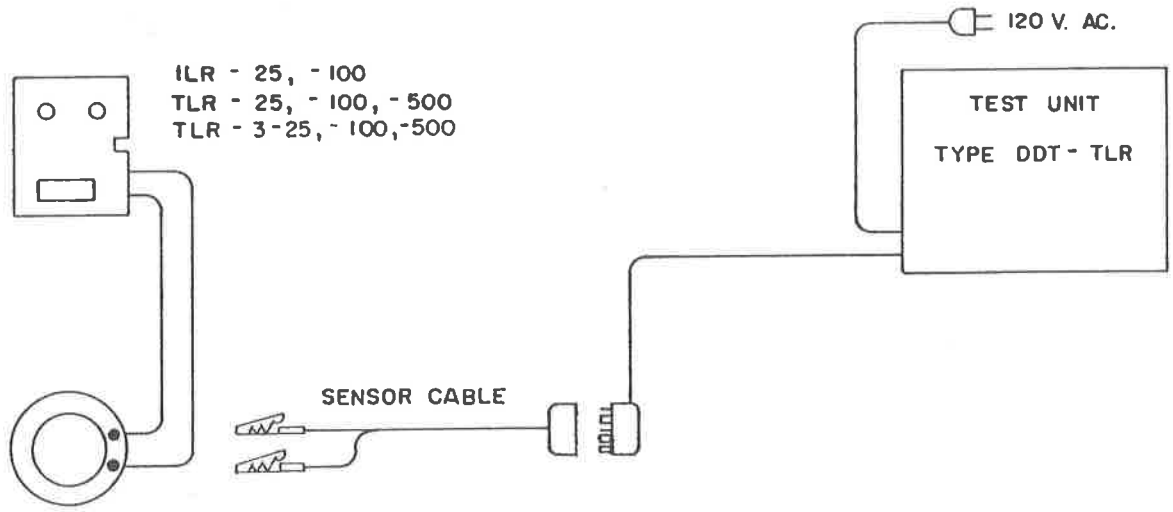


RESTRAINT CONTINUITY

FIG. 4

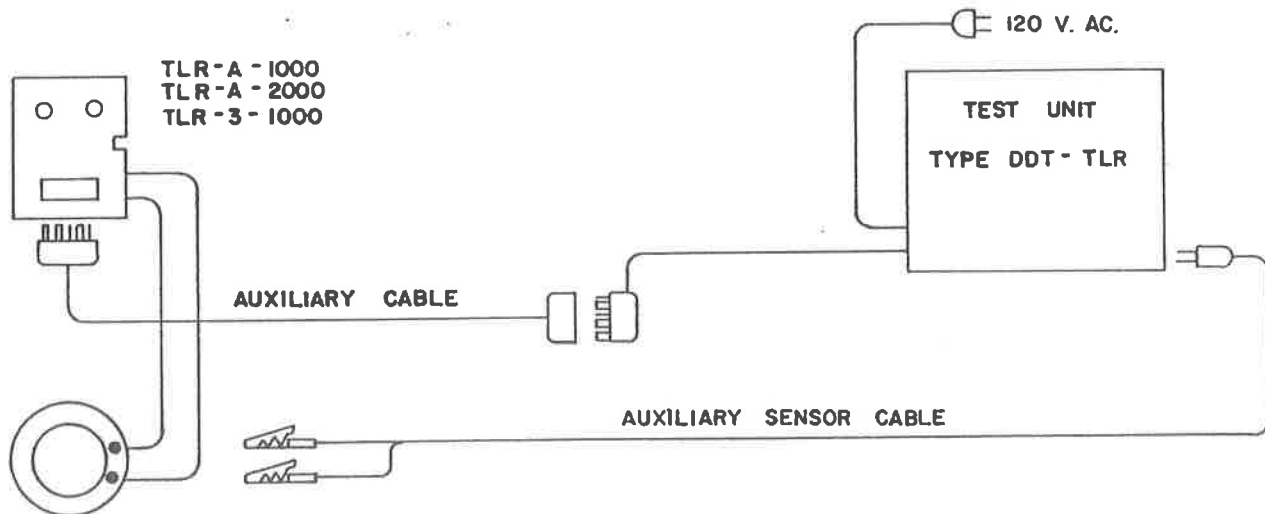


SENSOR WIRING CONTINUITY TESTS



APPLY SIGNAL TO THE SENSOR AND CHECK RELAY PICKUP

FIG. 5



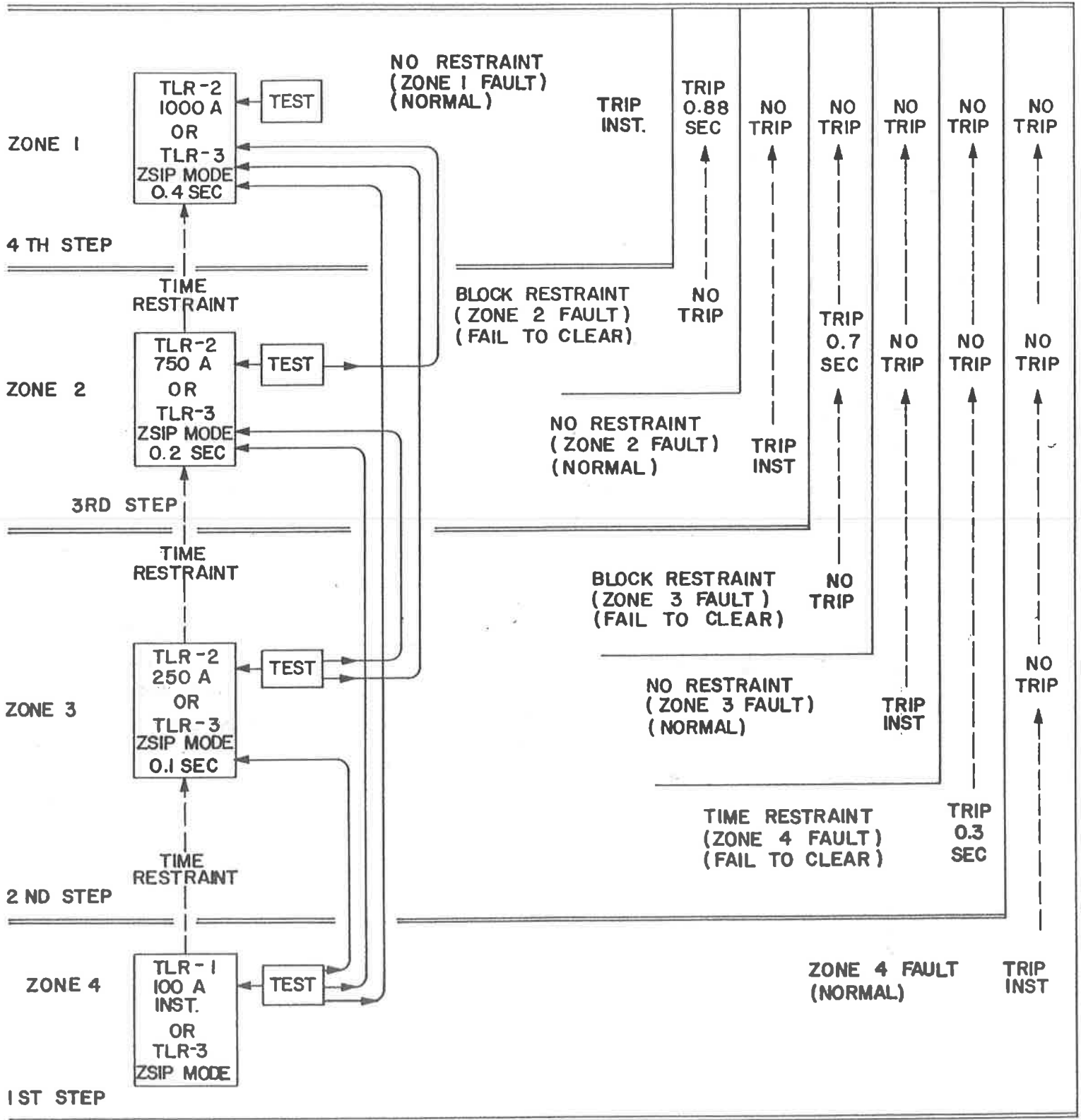
APPLY SIGNAL TO THE SENSOR AND CHECK
RESTRAINT OUTPUT FROM THE TLR

FIG. 6



FOR TESTING OF TYPE TLR AND ILR RELAYS
WITH TYPE DDT-TLR TEST SET

JANUARY 1980



SYSTEM COORDINATION
FIG. 7