INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPES HKB/TCU - SKB/TCU & SKBU RELAYS

INTRODUCTION

This instruction leaflet describes the overall functioning of HKB/TCU, SKB/TCU and SKBU relays when used in conjunction with a TC power line carrier channel. Detailed description of operation, as well as setting and maintenance recommendations for the individual relays for the phase comparison system are covered in the individual relay instruction leaflets; the description here is intended to supplement these relay instructions.

Unless otherwise stated, the following sections of this leaflet apply to all the HKB/TCU, SKB/TCU and SKBU relaying systems.

APPLICATION

Phase comparison carrier relaying is a well established system for the high speed protection of power transmission lines. The type HKB, SKB and SKBU relay are the high speed carrier relays used in conjunction with power line carrier equipment to provide complete phase and ground fault protection of a transmission line section. The basic concept of these schemes are the same as differential relaying. These relays operate on line current only, and no source of ac line potential is required. Consequently, it will not trip during a system swing or out-of-step conditions.

For normal application for two-terminal lines, the fault detector settings are determined from a comparison of the maximum load and minimum fault currents. With the required 1.25 ratio between FD-2 and FD-1 pickup, reasonable settings can usually be obtained. For three-terminal lines which approximately have equal currents fed in two-terminals and the current sum flows out the third terminal of the line, the ratio of 2.5 between FD-2 and FD-1 pickup should be used.

Since these relaying systems operate only during a fault, the carrier channels are available at all other times for the transmission of other functions.

EQUIPMENT COMPLEMENT

The equipment complement of these relaying systems are listed in Table I. The functions of each unit are:

TABLE I

	HKB/TCU	SKB/TCU	SKBU
HKB	X		
SKB		X	
SKBU			X
TCU	X	X	
TC Set	X	X	X
Coupling Capacitor	X	X	X
Line Tuner	X	X	X
Line Trap	X	X	X

The HKB relay includes the sequence filter, polar unit detectors to start the transmission of carrier and control the telephone type tripping relay.

The SKB relay includes the sequence filter, static fault detectors to start the transmission of carrier and control the high-speed attracted armature type tripping relay.

The SKBU relay is a package unit combined with SKB and TCU.

The TCU carrier control unit is energized from the output of the relay sequence filter. It has three functions during a fault, which are as follows:

1. To control the transmission of half cycle carrier signals.
2. To rectify the received half cycle signals of carrier from the remote transmitter.
3. To compare the phase position of the local and remote carriers to determine whether or not the relay should trip the breaker.

The TC carrier set has a 10 watt, 1.5 kHz band width, with transmitter and receiver.

The coupling capacitor with carrier auxiliary introduces the carrier signal on to the transmission line.

The line coupling tuner tunes out the capacitive reactance of the coupling capacitor and matches the transmitter or receiver circuits to the transmission line.

The line trap prevents short circuiting of the carrier transmitter output during a nearby external ground fault on the same phase wire to which the carrier is coupled.

Similar equipment is required at each line terminal of the protected line section. Each line section is considered as a unit and should be assigned a different frequency to minimize the possibility of interference with the other lines.

The transmitter-receiver sets are tuned to respond to the assigned frequency so that either receiver may receive a signal from the transmitter at the opposite end of the section. It is not necessary for the receiver to receive a signal from its own transmitter, since the carrier signal from each terminal serves only to block tripping at the opposite terminal for an external fault. Therefore, it is possible on two terminal lines to use two frequencies in this carrier scheme and obtain two independent carrier channels for transmitting auxiliary functions in two directions simultaneously.

OPERATION

Fig. 1 through Fig. 3 show the external schematic of the systems. The three-phase line currents energize the sequence filter which gives a single-phase output voltage proportional to a combination of sequence components of the line current. This output voltage will energize FD-1 and FD-2 fault detectors and control the transmission of carrier signals.

Internal Fault

Fig. 4, a block diagram of the phase comparison relaying system logic shows the output of the sequence filter passes through a low pass filter to provide a 60 Hz voltage. This voltage energizes the transmitter keying circuit which in turn controls the transmission of pulses on alternate half-cycle (at 60 Hz) if FD-1 also operates. The output voltage of low pass filter is also the input to a phase delay circuit and the local squaring amplifier. The phase delay is introduced to delay the local signal by an amount equal to the overall channel delay, and thus bring the local and remote signals in phase at the input end of the phase comparer during an internal fault. Current transformer connections to the sequence filters at the two terminals are such that carrier is transmitted on the same half cycles from both terminals during an internal fault. As shown in Fig. 5, on the half cycles that carriers are not transmitted from both transmitters:

a. The local squaring amplifier output developes trip pulses on these half cycles, and

b. no outputs from the local receiver and remote squaring amplifier, therefore the input of comparer AND from remote squaring amplifier will be a trip pulse. Therefore, the comparer will develope a trip signal. After 4 ms delay and with FD-2 picked up, the tripping relay will be initiated through operation of the Flip-Flop and trip amplifier, to trip the breaker.

The 4 ms delay is added to allow for differences in current transformer performance at opposite line terminals, relay co-ordination, and momentary

interuptions in carrier caused by arcing over of protective gaps in the tuning equipment.

The function of the squelch circuit is to hold off the carrier for a period of 150 ms after the breaker "a" contact opens. This is to prevent undesirable carrier blocking of another terminal which might be somewhat slower in tripping because of a lower value of fault current or of some other reasons at that terminal.

External Fault

During an external fault, when the fault detectors pickup. Carrier is transmitted from the two ends of the line on alternate half cycles. This occurs because the current at one end of the line has reversed with respect to the current for an internal fault. In this case, the local (or remote, if current reversed at the remote end) squaring amplifier will be shifted 180°, as shown in Fig. 5, i.e. the input from the remote squaring amplifier of the comparer AND will have a blocking signal while the local squaring amplifier output has a tripping signal. As a result there will be no tripping signal output from the comparer and tripping will be blocked.

Transient Blocking

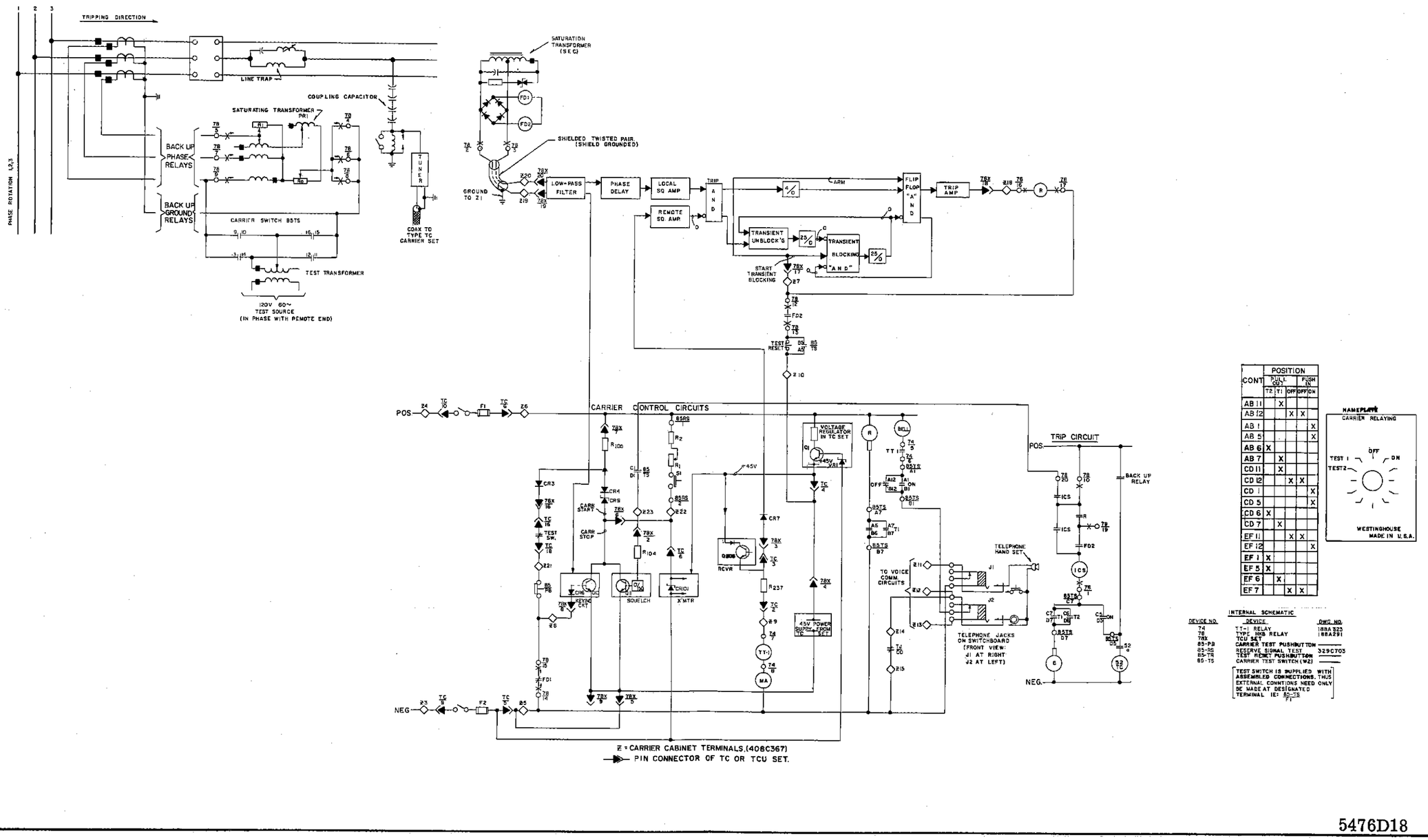
Since the sequence filter and the low pass filter contain reactive circuit elements, discharge of their stored energy after the clearing of an external fault might cause an incorrect relay operation or a false tripping may result during a sudden reversal in the direction of fault power flow in the protected line, due to the sequential clearing of a fault on a parallel line. In order to improve the security of this relaying system against such conditions, a transient blocking circuit has been added.

For any fault, if tripping does not occur in less than 2 cycles after FD-2 operates, the Flip-Flop will be desensitized so that a transient pulse cannot operate it. However, if an internal fault developes before the external fault is cleared, the change in phase position of the local and remote carrier pulses will cancel the transient blocking after approximately 2 cycles to allow a slightly delayed tripping.

SYSTEM FUNCTIONAL TEST PROVISIONS

It is desirable to check periodically the condition of the carrier set to determine its ability to send and receive a carrier signal. For this purpose a test switch 85/PB is connected to the carrier start elements. Pressing the test pushbutton sends a carrier signal which is received by the remote receiver to operate an alarm relay TT-1 and energize a milliammeter. If the carrier set is not functioning properly, the alarm is not heard and the milliammeter does not deflect, indicating trouble which must be investigated and corrected.

Operation of these relaying systems for all faults are dependent upon correct functioning of the carrier equipment components as well as the HKB, SKB or SKBU relay itself. The test facilities which including a type W2 switch and a special testing transformer provide a simple manually operated test procedure for these systems that will check the combined relay and carrier equipment. Detailed test procedure is described in I.L. 41-951.3 and 41-954, for the HKB/TCU, SKB/TCU, and SKBU phase comparison relaying systems respectively.



CONT	POSITION PULL OUT T2	PULL OUT T1	PUSH IN OFF	PUSH IN ON
AB 11		X		
AB 12			X	X
AB 1				X
AB 5				X
AB 6	X			
AB 7		X		
CD 11		X		
CD 12			X	X
CD 1				X
CD 5				X
CD 6	X			
CD 7		X		
EF 11			X	X
EF 12				X
EF 1	X			
EF 5	X			
EF 6		X		
EF 7			X	X

NAMEPLATE
CARRIER RELAYING
TEST 1
TEST 2
OFF
ON
WESTINGHOUSE MADE IN U.S.A.

INTERNAL SCHEMATIC

DEVICE NO.	DEVICE	DWG. NO.
74	TT-1 RELAY	188A323
78	TYPE HKB RELAY	188A291
78X	TCU SET	
85-PB	CARRIER TEST PUSHBUTTON	
85-RS	RESERVE SIGNAL TEST	329C703
85-TR	TEST RESET PUSHBUTTON	
85-TS	CARRIER TEST SWITCH (WE)	

TEST SWITCH IS SUPPLIED WITH ASSEMBLED CONNECTIONS. THUS EXTERNAL CONNTIONS NEED ONLY BE MADE AT DESIGNATED TERMINAL IE: 85-TS F1

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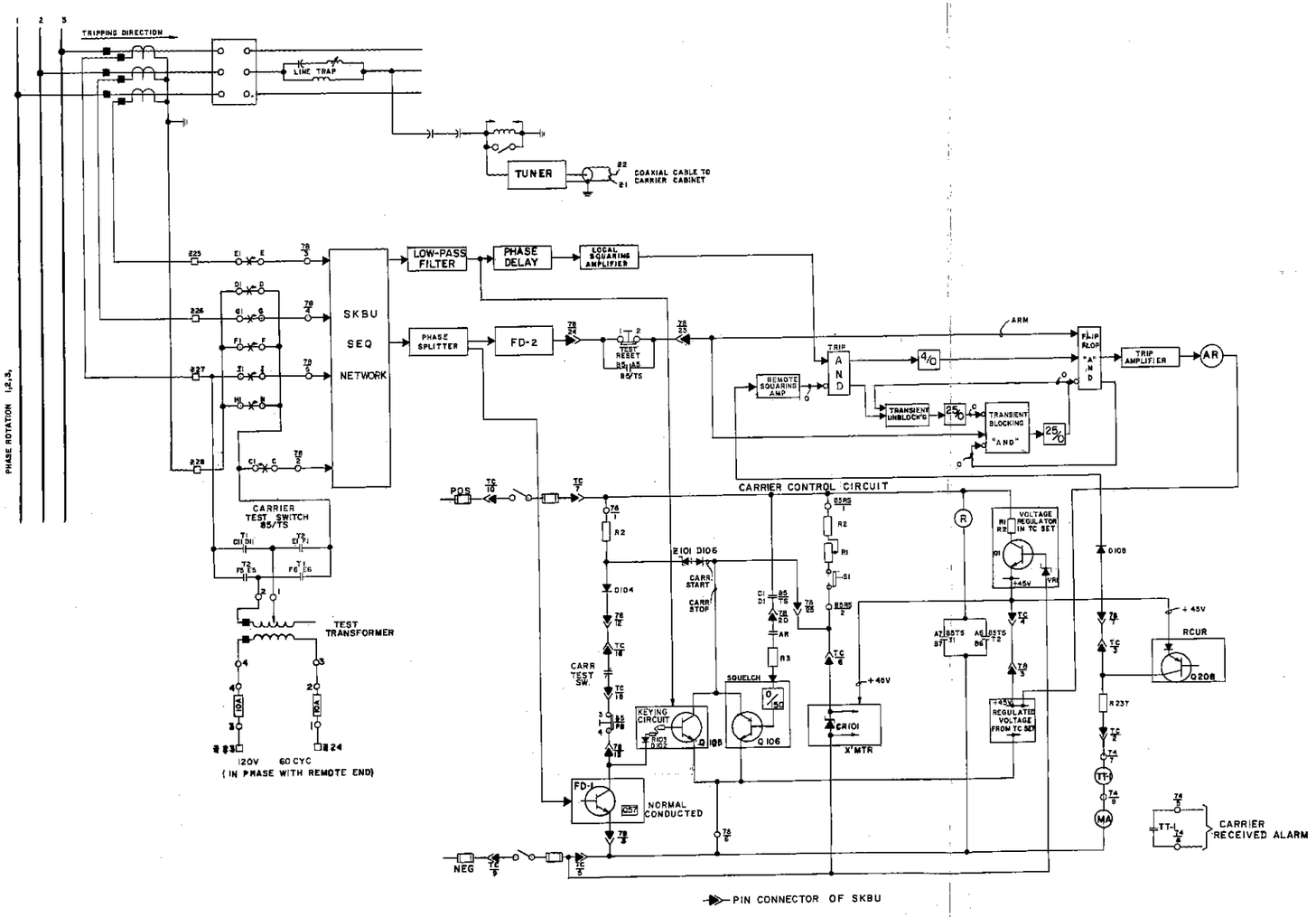
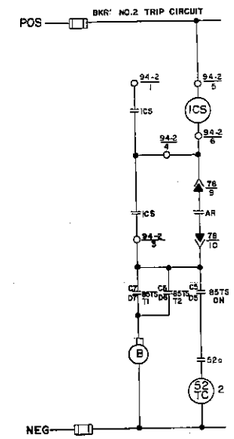
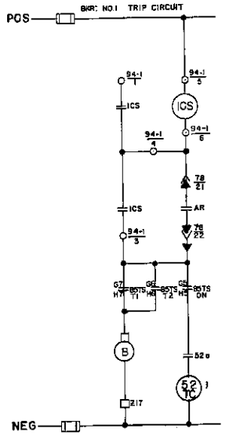
Fig. 1 External Connection of HKB/TCU/TC Phase Comparison Relaying System.







85/TS TYPE W2 CARRIER TEST SWITCH

CONTACT	POSITION TEST 2 HANDLE OUT	TEST 1 HANDLE OUT	OFF HANDLE IN OR OUT	ON HANDLE IN
A5-B5				X
A6-B6	X			
A7-B7		X		
C11-D11		X		
C1-D1				X
C5-D5				X
C6-D6	X			
C7-D7		X		
C10-D10				X
F5-F7	X			
F6-F8	X			
G5-H5		X		
G6-H6	X			X
G7-H7		X		

X: DENOTES CONTACT CLOSED

DEV. NO.	DEVICE	INT. SCHEMATIC
74	TT-1 RELAY	848 A640
78	SKBU RELAY	756 J 654
85 RS	RESERVE SIGNAL DETECTOR	329 C 703
85/TS	TYPE W2 TEST SWITCH	
94-1,94-2	TR-1 RELAY	836 A 799
TC	TC CARRIER SET	

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Fig. 2 External Connection of SKBU/TC Phase Comparison Relaying System.

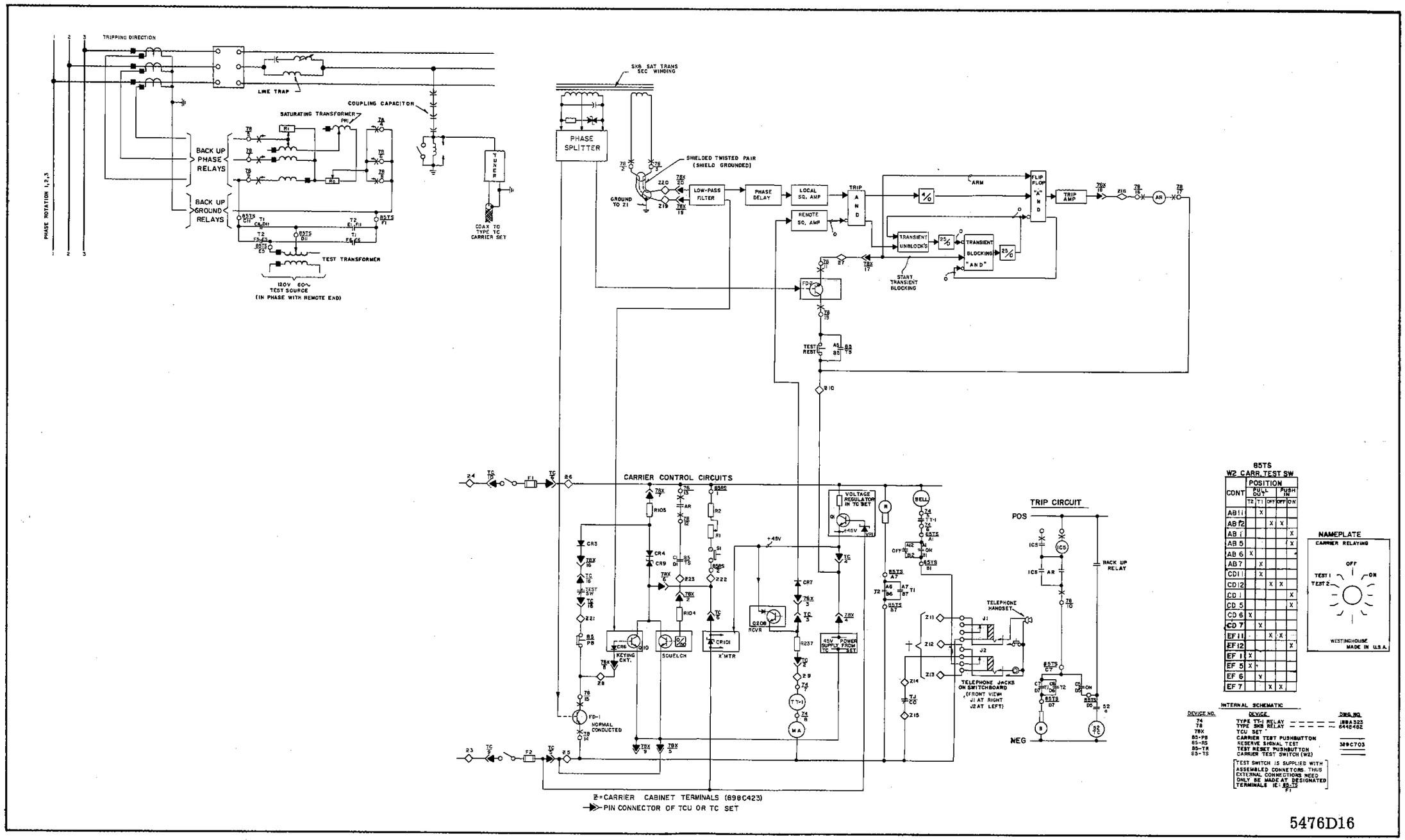

Fig. 3 External Connections of SKB/TCU/TC Phase Comparison Relaying System.

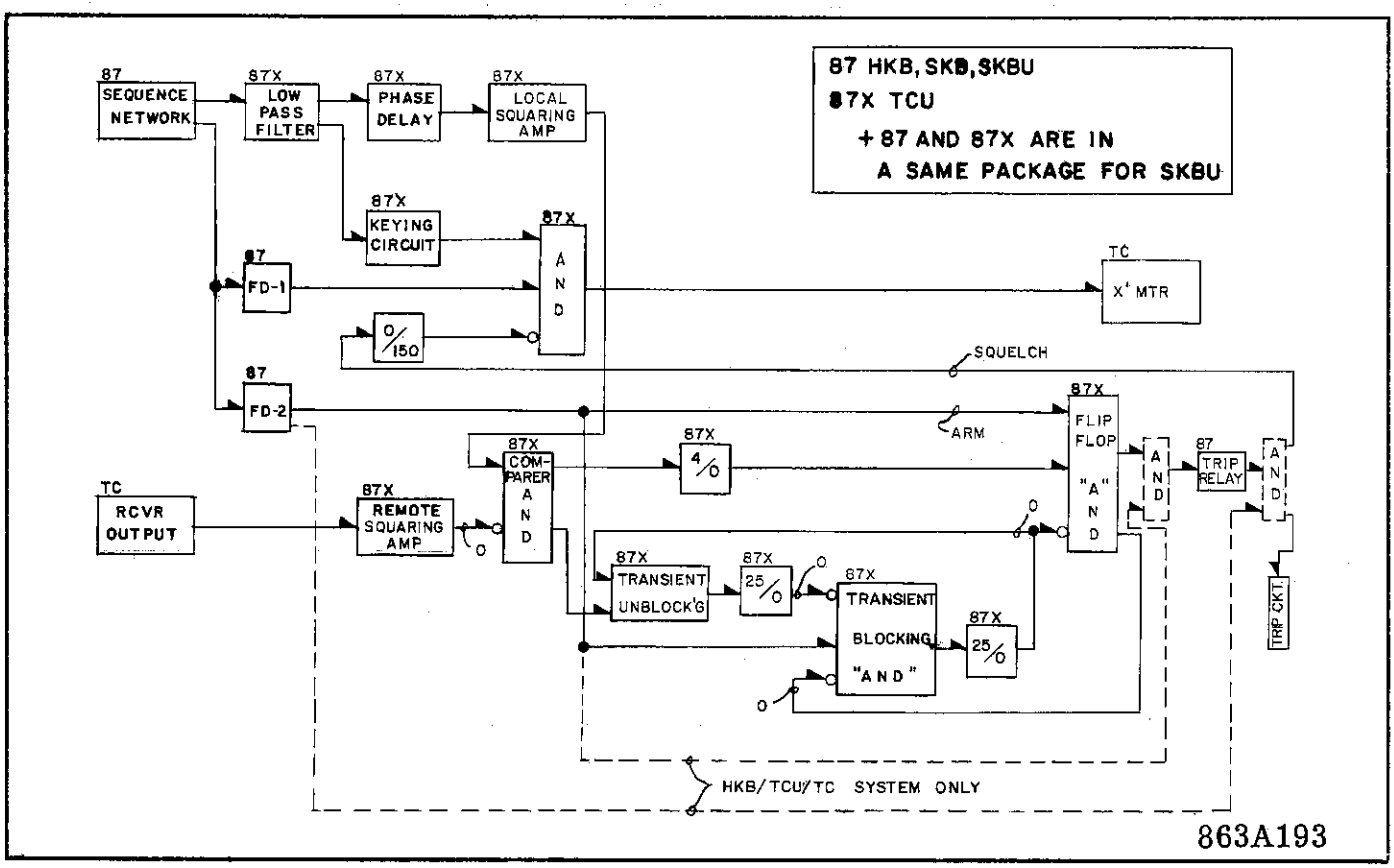

Fig. 4 Block Diagram of Phase Comparison Relaying Logic.

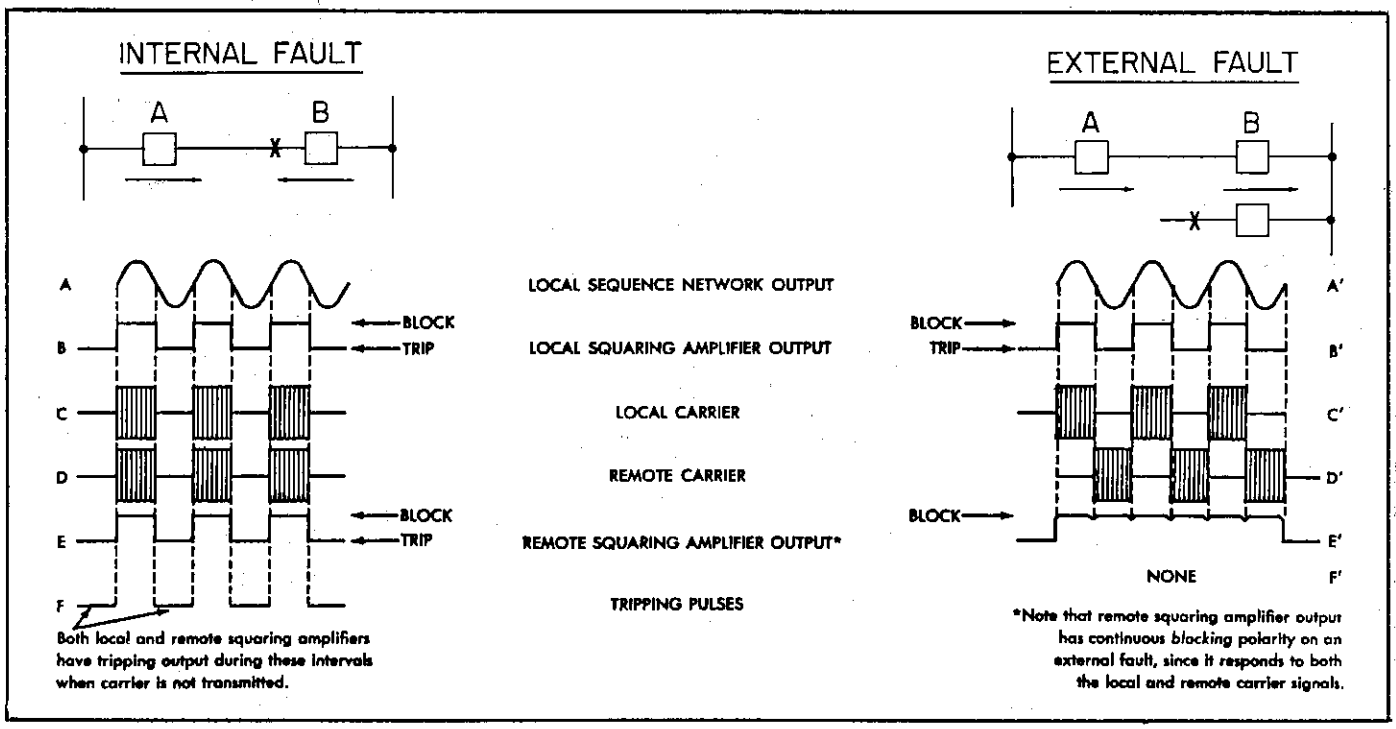

Fig. 5 Phase Comparison Transmitter Keying.

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