

General Description of SSl Selective  
Signaling Systems

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1. GENERAL

A. Scope

These notes provide general descriptive information on the SSl Selective Signaling System. This system provides a means for personnel at stations bridged to a 4-wire private line circuit to signal selectively other stations bridged to the line.

B. Use of the System

The SSl Selective Signaling System is intended as a signaling system for use on private lines for FAA, air lines, pipelines, utilities, and the like, and also as a signaling link for order wires for Telephone Operating Companies.

C. General Operation of the System

The SSl System is applied to a standard 4-wire multiparty private line voice network. SSl circuitry permits sending and/or receiving at the stations, including a multiplicity of points within a station. Any sending point can signal any receiving point of another station. Each receiving point is designated by two digits. When a signal is sent, it is received and decoded at all locations, but signaling is carried out only at the point or points corresponding to the code transmitted. Frequency shift tone signaling (2600-2400 cycles) is employed between central offices on the backbone route. In the central offices standard transistor or vacuum tube SF units are used for signaling reception, but a separate keyer unit performs the sending function. Unlike normal toll circuit SF operation, tone is off the line at all times except during pulsing also, frequency shift, rather than on-off signaling, is used.

Loop or DX signaling is used between central offices and customer way stations.

Codes are generated by two pulls of a standard dial which sends dc pulses (loop or DX) to the central office to key an oscillator. At other central offices, SF receivers receive the tones and convert them back to dc.

The code is either decoded and a short pulse of one polarity or the other is transmitted over a loop signaling link to the proper way station, or the code itself is sent over a DX signaling link and decoded at the way station. The former arrangement is used when it is necessary to have only one or two decoded output at the way station, while the latter arrangement permits selection of three or more points. The output in either case is a short (100 ms) closure to operate the alerting or control initiating equipment.

#### D. Capacity of the System

The system capacity is 81 two digit codes generated by a standard 6 type dial. The digit one is not used for station codes.

Stations may be designated as sending and/or receiving stations. Local key arrangements (not part of SSl) can permit a number of operators, at any station, to have access to the sending equipment. One or more codes may be assigned to any station to provide for selective signaling of a plurality of positions at that station.

Group codes may be used to call a predetermined number of station codes simultaneously. These points can also respond to individual codes.

#### E. Summary of Principal Features

The principal features included in the system are as follows:

- (a) Selective signals are sent and received at a plurality of stations on a multipoint 4-wire private line voice circuit.
- (b) The system capacity is 81 codes generated by two dial pulls (digit "one" not used).
- (c) Tone signaling is used on the backbone route. The tone equipment is located in the central offices along the backbone route.
- (d) DC signaling is used between customer way stations and central offices.
- (e) At the selected point, a 100-millisecond pulse is produced.

- (f) For the commercial applications, sending and/or receiving points are at the customers' premises. For the telephone order wire applications, these points are in the central offices, and the dc signaling loops are not used.
- (g) The central office and way station equipment are made as packaged units including a transistor SF receiver in the former. Provision is made, however, to use an existing nonpackaged vacuum tube SF receiver if desired.
- (h) Codes may be dialed in succession to establish conference calls.
- (i) Master codes signal a number of points simultaneously. These points can also respond to individual codes.
- (j) A connection between two SSl systems, in order to signal from one to the other, may be made by dialing a code.
- (k) The system has the same talk-off protection provided by normal SF operation.
- (l) To prevent code mutilation, voice paths of all stations and signaling paths of all stations except the one sending, are locked out, and busy tone is provided, during the dialing interval.
- (m) A 6-second time out restores the system to normal if one one digit is dialed. Dialing a "one" causes immediate restoral.
- (n) A fault at a way station or on a loop, puts only one station out of order, rather than the whole system.
- (o) The system will signal reliable in the presence of return losses as low as 10 db.

## 2. SYSTEM PLAN

### A. General Description

The SSl Selective Signaling System operates over a 4-wire multistation private line. It utilizes a 2600-2400 cycle signaling arrangement on the backbone route, (through route), and dc signaling techniques on the bridged circuits

to way stations. Codes are originated by dials, and a relay selector unit, (decoder), receives and decodes these codes.

The system is ready for dialing as soon as the handset is removed from the switchhook, or the equivalent is performed by key operation. Dialing is blocked, however, similar to the case of home extension telephones, if another handset connected to the same central office loop, is also off-hook at the time. Before dialing, the operator monitors the line for speech. If it is free, two digits are dialed to send, by dc means, any one of the 81 possible codes to the central office. In the central office, a keyer, actuated by local dc signals or by the loop or DX circuit, converts the dc pulses to 2600-2400 cycle tone pulses, and sends them to the other SF receivers on the backbone route. Here they are converted back to dc signals and either operate a decoder in the central office, or the code is sent on a DX signaling basis to the way station and is then decoded. Hence, all decoders respond. If the one associated with a particular dialed code is located in a central office, it produces a momentary (100 milli-second) output which is sent on a loop basis to the way station (Figure 1). If the decoder is in the way station, it provides the momentary output directly (Figure 2). In both cases the momentary output is used to actuate other signaling or control equipment.

If the sending or receiving stations are located in the central office, as in the application to order wire, then the loop or DX links are not required. In other applications, all tone equipment is located at the way station. In some of these cases the carrier terminates at the way station, and in other cases the carrier terminates at the central office and tone is transmitted over the local loops. Again, the loop or DX signaling links are not required.

Upon receiving the first pulse of any digit, the central office equipment at all locations, except the sending stations, opens the loop to the way station, and sends 2600 cycle tone over them to serve as busy tone. This condition persists until two digits have been dialed, or for 6 seconds, which is the time allowed for dialing the second digit. The outgoing speech paths and signaling paths are also opened during this interval.. Thus, if another operator picks up during the dialing interval, he hears busy tone, and he cannot interrupt the signaling by talking or attempting to signal.

If an operator dials a digit in error, he may dial the digit "one" to effect an immediate cancellation of the 6-second time out period, and redial immediately. An operator may dial a number of codes, without any waiting period, in order to establish a conference call.

Provision is made for dialing into another SSl System. This is accomplished by dialing a code to set up a transmission path to the other system, and then following the usual procedure. At the end of the conversation, a code is dialed to release the connection.

An operator may not dial another operator connected to the same central office loop. This prevents the use of the private line network for on premise calls.

#### B. Operation of 2600-2400 Cycle Signaling Circuit

The backbone ac signaling system consists of two principal units. These are the standard transistor SF receiver, and an SSl keyer. The first of these units is used only for the reception of tone signals, and the latter for the generation and pulsing of the signals.

Since the SSl Selective Signaling System is used only during signaling, it is in the same condition both when the line circuit is idle, and when there is talking on the line. This means that since the SF receivers unit must be in the high guard condition during talking, in order to avoid talkoff, they must also be in this condition when the line is idle. Thus, battery is on the M lead into the SF receiver during the idle condition.

In the talking condition, dial pulses are not corrected by the SF pulse corrector, the SF sensitivity is low to ac signals, and the receiver requires pulses of longer duration than for the case when the M lead is grounded or opened. Hence, it is not possible to dial reliably under these conditions.

To obtain reliable dialings, the SF receivers are shifted into the dialing or low guard condition upon receipt of the first pulse of 2600-cycle dialing. This is accomplished by making this pulse at least 100 milliseconds long to insure that it will operate the SF unit. The E lead output of the SF then serves to operate other circuitry which opens the M lead for the duration of the two digits, or for each digit separately, depending upon the arrangement.

The keyer unit contains a 2600-2400 cycle transistor oscillator, and circuitry for pulsing this oscillator. The input to the keyer is normal dial pulsing, but the output is frequency shift tone keying with the first pulse of 2600 cycle tone at least 100 milliseconds long. This is accomplished by the use of a delay circuit associated with the keyer which delays all pulses, but fills in most of the delayed space preceding the first output pulse. Figure 3 shows the input and output of the keyer for a single digit.

The 2400 cycle tone is inserted between pulses and for a longer time at the end of the last pulse to insure that the SF receivers release at the end of each 2600 cycle tone. The 2400 cycle tone, which enters the guard channel of the receivers forces them to release in spite of any delayed echo pulses of 2600 cycle that might tend to hold the receiver operated.

The keyer contains a fail-safe feature in that if its input lead loses its normal ground for longer than about 100 milliseconds, a continuous tone is prevented from going out on the line. In other words, the keyer must be pulsed in order to put out tone. It cannot do so in an idle condition. Thus, if a fault should cause a continuous battery input to the keyer, only a momentary spurt of tone would be transmitted, and the whole system would not be out of order because of one station. Provision is made for such a condition to operate a central office alarm circuit if desired.

#### C. Use of Loop and DX Signaling Circuits

If a way station associated with a particular central office requires only one or two selections, the "E" lead output of the SF unit is connected to a decoder at the central office. The decoder receives the code, and translates it to a short ground pulse on a particular output lead. Battery, of either one polarity or the other, depending on the particular code, is applied to the pair which is used to receive speech from the way station. At the way station, one of two relays, depending on the polarity, operates to give a closure of at least 100 milliseconds. The closure is used to actuate the alerting equipment. In this type of dc signaling, codes are transmitted to the central office on the other 2-wire half of the 4-wire circuit. The maximum allowable loop resistance is 4000 ohms. Figure 1 shows a typical setup at such a station.

If a way station associated with a particular central office requires three or more selections, DX signaling is used. In this case, the "E" lead operates the DX circuit over the pair which transmits speech to the way station. The

code is received by a decoder located in the way station and the output is converted into a pulse of at least 100 milliseconds. In this type of signaling, codes are transmitted from the way station to the central office over the same pair which receives them. Figure 2 shows this configuration.

#### D. Operation of Decoder

The purpose of the decoder circuit is to count incoming dial pulses, determine the digits dialed and decode each 2-digit code into a particular 100 milliseconds output ground. The input signals to the decoder are transmitted over the "E" lead, either directly from an SF unit, or via a DX signaling circuit. A counting chain of five relays is used in the basic counting circuit.

This basic equipment is designed to decode nine codes in any one of nine tens digits or four codes in each of two tens digits. Additional tens digit relays may be supplied as needed on another unit to decode up to the full 81 codes.

The decoder is seized by the first digit, and restores after the second digit, or after an interval of 6 seconds following the first digit. If a "one" is dialed following a single digit, the decoder restores immediately. This feature provides a cancellation of the time out waiting period in the event that a first digit is dialed in error.

If more codes are required at a particular way station than described above, a code relay unit is used. This unit is designed to store a first digit and to connect nine code leads (representing a possible nine digits), one of which will be energized at the end of the second digit. This equipment will provide 72 codes in addition to the nine codes furnished by the decoder unit.

#### E. Way Station Sending Equipment

At each way station where sending is required, a sending relay circuit is used in conjunction with a standard 6-type dial. The circuit is arranged for either loop signaling or "M" lead signaling.

During the off-normal time of the dial, the transmitting loop is shorted, so that room noise cannot block signaling.



## F. Circuit Arrangements

The following circuit arrangements are available for each 4-wire loop.

- (1) Send only
- (2) Receive only - one or two codes
- (3) Receive only - three or more codes
- (4) Send and receive one or two codes
- (5) Send and receive three or more codes

## G. Loop Bridging Arrangements

If 2- or 3-way stations are in close proximity to a common central office, a common central office SF receiver and keyer may be used. This arrangement allows an operator on any of these loops to signal to the other loops operating from the same central office.

## H. Interarea Switching Arrangements

Provision is made to dial from one private line circuit into another. If there are two private line circuits, each will carry its own traffic and work independently of the other. If it should become necessary, however, to sometimes call from a station connected to one of the circuits to a station on another, operation is as follows.

A special code is dialed which connects the two private line circuits together. The code of the called party is then dialed. Upon completion of the call, a special code is dialed to disconnect the two circuits.

Under this type of operation, if some of the same codes appear in both private line circuits, the ringing of such a code can cause both such parties to be alerted. Such conflicts can sometimes be averted, however, by the careful assignment of codes.

## I. Loop Cutoff Arrangement

If an excessively noisy loop must be employed as of the network, the connection of this loop to the backbone circuit may be controlled by the way station switchhook or equivalent key. This arrangement still permits incoming signaling, even though the voice path is disconnected from the backbone circuit until the handset is removed from the switchhook.

### 3. ASSIGNMENT OF CODES

#### A. Economic Considerations

The SSl Selective Signaling System has a capacity of 81 codes. This means that up to 81 different stations can be assigned individual codes and when any one is called, no others will be called. These stations can all be at separate location, or a number may be located at a common point and served by a common loop from the central office. An example of the latter is an ARTC Center where 20 or 30 codes might be assigned.

The code relay in the decoder unit is arranged to decode nine codes in any one tens digit, or four codes in each of two tens digits. If it is necessary to decode more codes than this, at any one decoder location, additional code relays must be provided. In the interests of economy, it is desirable to assign codes so as to require as few code relays as possible. For example, if a location has, say 15 codes, the proper selection of first digits will allow all decoding to be done with the code relay in the decoder, and only one additional relay. The same type of reasoning applies in cases where two or three loops, each assigned one or two codes, utilize common decoding equipment in the same central office. Proper assignment of codes will allow all decoding to be done with the one relay built into the decoder unit.

It is important to note that the above remarks are an economic consideration only. If other factors deem it advisable to select codes according to another method, this may be done, but at an increase in cost.

#### B. Multiple Usage of Codes

Under some conditions it is possible to obtain more than 81 individual selections with the SSl System. This is made possible by the fact that if a number of codes are assigned to one loop, such as in an ARTC Center, personnel at the various points cannot use the SSl System to signal other points on the same loop. This is not an undesirable feature of the system, but is arranged this way so that the private line facilities are not used when other local means of communication will perform the job.

Suppose then, that there are two ARTC Centers bridged to a private line, and no other stations exist. If there are 50 selected points assigned to each center, the SSl System can be used to enable any point at either center, to call any of the 50 points at the other center, without alerting the position with the same code at the originating center.

A condition might exist similar to the above, but with another station; this one with only a few codes assigned to it; also bridged to the private line. Let us say that these codes are not duplicated at any of the large centers, but that codes assigned to the centers are duplicated with each other. Under these conditions, each center may select a position in the other center or in the smaller station, but if the smaller station signals one of the centers, he will also signal the position with the corresponding code in the other center.

The point here is that under some particular circuit and traffic condition, good judgement in the assignment of codes can permit multiple usage of codes.

#### 4. EQUIPMENT ELEMENTS

##### A. Equipment Arrangements

Equipment arrangements at both central offices and way stations vary for each particular job. The equipment is, however, provided on a building block basis. This means that, within reasonable limits, only the necessary components are used for each job.

All units, with the exception of the transistor SF receiver, are 19-inch plates.

In the central office, the units are placed alongside the vertical SF receiver so that the complete packaged unit mounts in a 23-inch bay. If more than 14 inches (the height of the SF unit) of vertical room is required by the 19-inch panels, the remainder are mounted below the SF unit, and supplied with adapters to extend them to 23 inches. Figures 4 and 5 show the equipment arrangement for the circuits of Figures 1 and 2 respectively.

##### B. Description of Units

The SSI System utilizes the standard SF receiver, DX signaling circuit, signal lead extension circuit, and the units described below.

##### a. Decoder and Test Jack Unit

This unit may be mounted at either the central office or way station. Its purpose is to count the incoming pulses and register a momentary ground on a selected output lead. When it is mounted in the central office, it also shifts the SF guard during incoming pulsing by opening the M lead. When only one loop is used, and it is mounted in the central office, it also opens loops, switches busy tone,

and opens the outgoing signaling path, during incoming pulsing. The test jacks provide for tests on the E and M leads.

b. Sending Relay and Code Relay Unit

This circuit provides the extra tens relays to decode more than the nine codes available from the decoder. The sending relay circuit is also provided optionally to work from the dial in the central office in the order wire application, or in the commercial application if this unit is mounted at the way station.

c. Keyer Unit

This panel contains the 2600 cycle oscillator, means to frequency shift key this oscillator and apply the pulses to the line, and the first pulse elongation circuitry.

d. 4-Wire Loop Terminating, Loop Sending - 1 or 2 Codes, and Loop Signal Receiving Unit

This panel contains the loop terminating coils, jacks to test at various parts of the coils, and the loop signaling circuits. The loop signaling circuits are supplied optionally.

e. Pulse Repeater and Busy Tone Circuit Unit

When two or more loops leave the same central office, this unit supplies the circuitry which opens loops, switches busy tone, and opens the outgoing signaling paths during incoming pulsing. When one of these loops is itself pulsing, the same functions are performed, except that the outgoing signaling path for this one loop is maintained.

f. Interarea Switching Unit

This unit is used only for the interarea switching function. It provides the circuitry to switch two networks which both have appearances in the same central office together. In the event that the two networks do not terminate in the same office, an amplifier is provided to monitor signals from the distant office.

g. Guard Transfer and Busy Tone and Loop Cutoff Relay Unit

The first part of this circuit is used in the central office when the decoder is at a way station, and only one loop is used. During incoming pulsing it opens loops, switches busy tone, opens the outgoing signaling

path, and shifts SF guard. The second part is used for the loop cutoff feature described earlier. Either of the parts including up to three of the latter, are supplied optionally.

h. Sending Relay, Receiving Relay - 1 Code, Receiving Relay - 2 Codes

This unit is used at the way station. It provides the sending relay circuitry for both loop and DX signaling and the receiving relay circuitry for the loop signaling. Either part is supplied optionally.

C. Cross Connections to Customer

The decoder unit outputs appear on a terminal block on the decoder unit. When the decoder is located at a way station, this output terminal is connected to operate leads in the customer's equipment. In most cases this will probably be other telephone equipment.

When loop signaling is used, the Receiving Relay Unit output is connected to customer equipment.

5. TRANSMISSION

A. SF Signaling Circuit

Standard transmission levels for speech are used at all points of the circuit. Signaling tone, however, is 8 db higher than normal SF usage, so that the tone amplitude is equal to the transmission level point at all parts of the circuit. Steady tone is not used in SSI signaling.

B. Loop Signaling Circuit

For loop signaling, a polar relay is located in the central office. The procedure for adjusting this relay circuitry to the loop is given on the SD drawing. The maximum loop resistance allowable on the loop signaling circuit from the central office to the way station is 400 ohms.

C. DX Signaling Circuit

The DX signaling circuit is aligned according to standard specifications.

D. Dial Pulsing Leads

Up to 200 ohms resistance is permitted in each of the dial leads for either loop or DX signaling.

6. POWER

Relay equipment at the central offices is arranged for -48 volt operation. If the vacuum tube SF receiver is used, +130 volts is also required.

The sending equipment at way station is arranged for -24 or -48 volt operation. When the decoder is located at the way station, which is the case in DX signaling, -48 volts must be supplied.

Power for the loop signaling receiving relays at the way station is supplied from the central office.

7. INTERCONNECTION WITH STATION EQUIPMENT

The SSI Selective Signaling System is not designed to give continuous, or locked in, closures. Only a momentary closure is supplied. The closure lead is connected to the station equipment which must provide its own lock up and release features as required.

8. TESTING AND MAINTENANCE

The SSI Selective Signaling System is designed for easy maintenance.

Maintenance of the standard SF unit can be carried out, in offices which have other SF units, according to the standard practices for the unit. In installations where no other SFs are installed, a limited amount of testing may be done or the unit may be taken to another point for repair.

The keyer unit may be checked for pulsing by means of a 2B pulse checking test set. The 2B battery supply filter and jacks employed with the 2B set may be mounted with the SSI equipment if no other filter and jacks are available within easy reach.

If trouble is suspected in the transistor oscillator, its output amplitude and frequency can be checked in the central office.

The DX signaling circuit is maintained according to standard practices.

The loop receiving relay circuit is adjusted according to procedures given on the SD drawing.

All other units of the system utilize standard relay equipment, and require no special adjustments.

#### 9. OPERATION OF SSl WITH NO. 300 SWITCHING SYSTEM

At ARTC centers, the SSl Selective Signaling System is used in conjunction with the No. 300 Switching System.. The operation is slightly different in this case, and is described below.

Before dialing, the operator seizes a register sender. He then key pulses two digits. The sender sends out a "one," and then the two digits; and then drops off the line. This means that in order to send two codes in succession, it is necessary to reseize the sender.

If a dialing error is made on the first digit, the correct procedure is to press the "CLEAR" key on the 300 equipment, and then key pulse again. By this action, the sender is cleared, but not released, making it unnecessary to reseize the sender. Upon keying the correct code, a "one" precedes the digits, clearing the decoders at all other locations. If a "one" were keyed on the second digit, to cancel the error, instead of pressing the "CLEAR" key, the sender would release, and it would be necessary to reseize it.

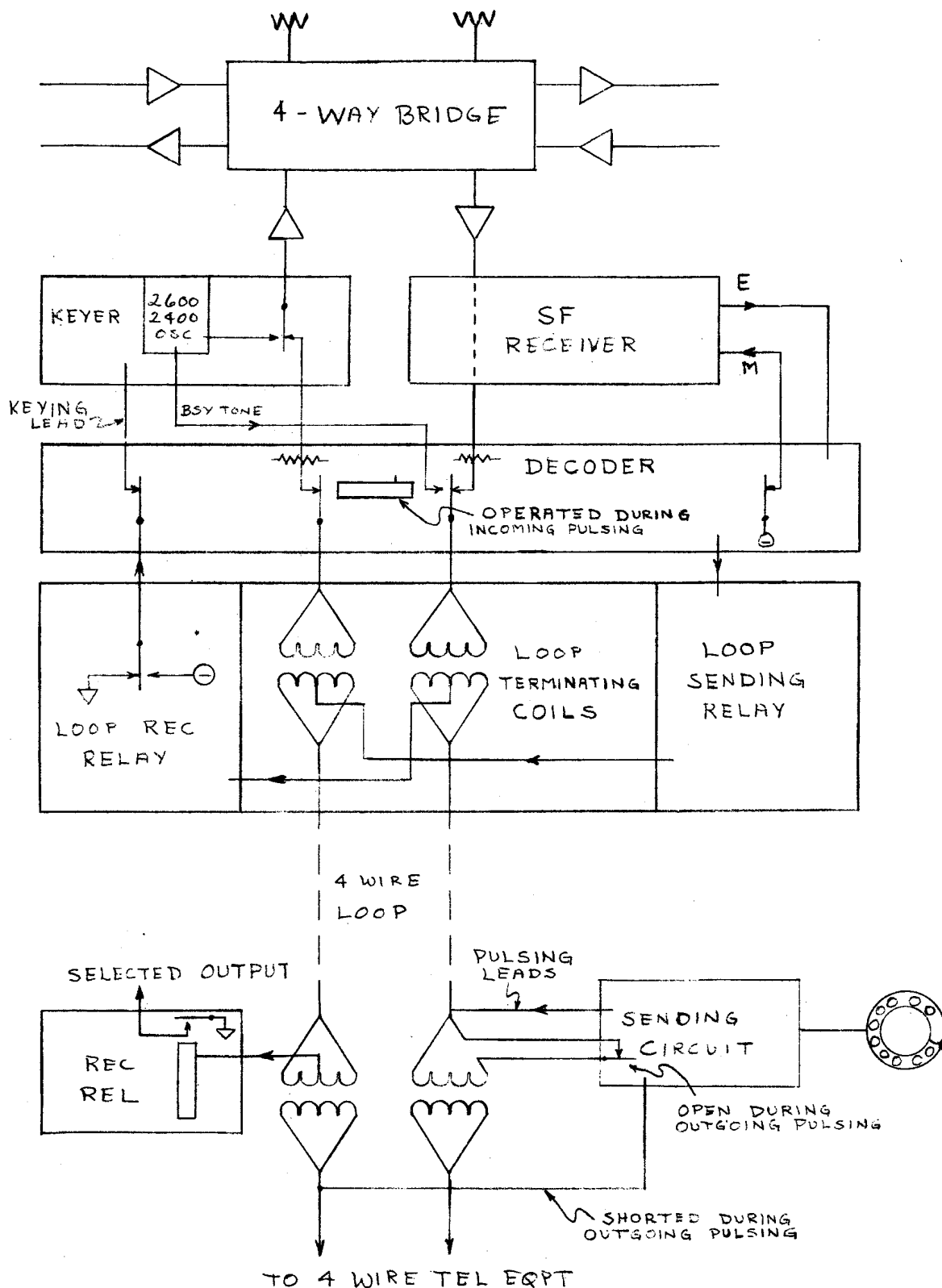


Fig. 1 - SSI Central Office and Way Station Equipment For Loop Signaling When One Loop Is Used



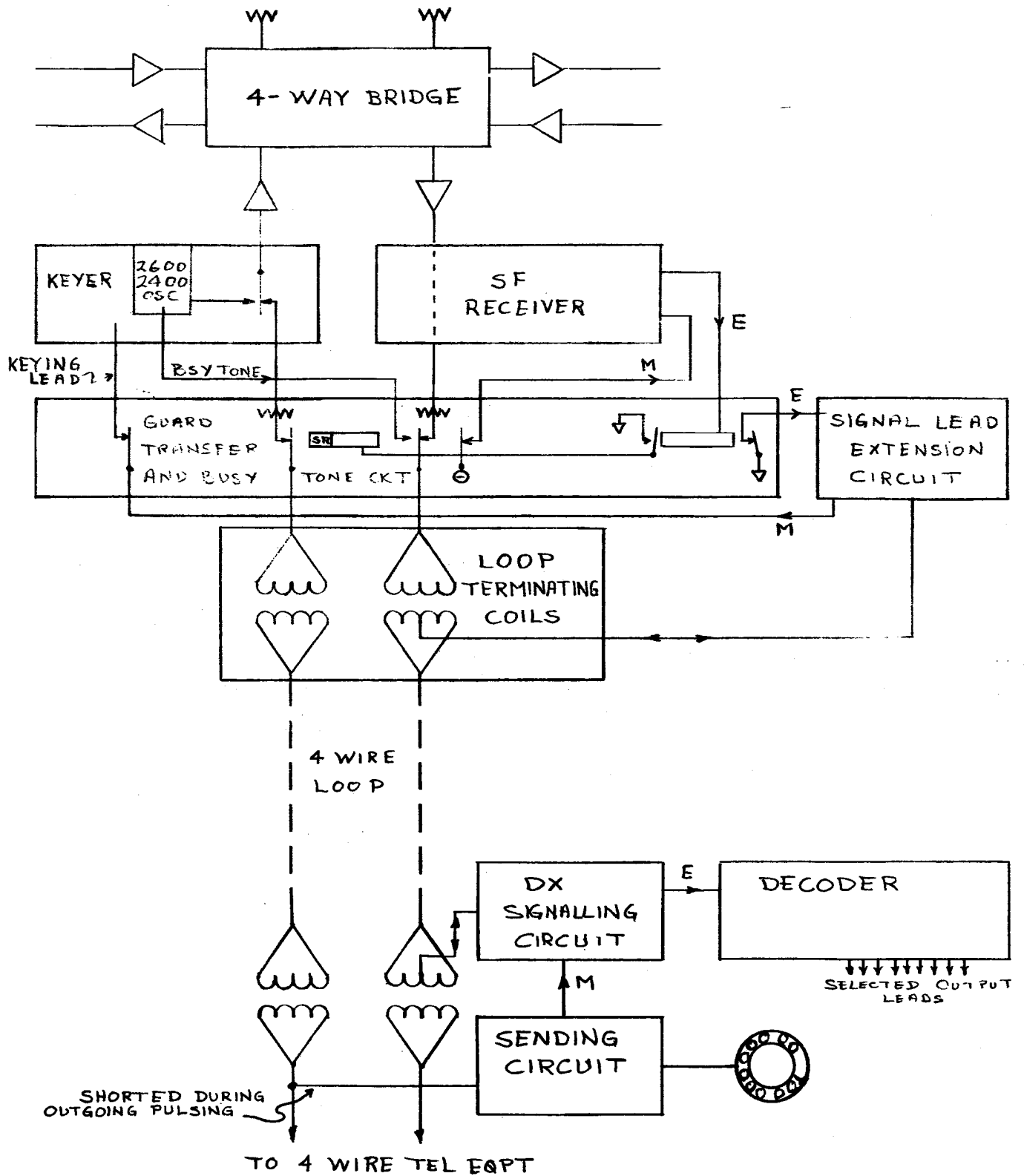


Fig. 2 - SS1 Central Office and Way Station Equipment For DX Signaling When One Loop Is Used

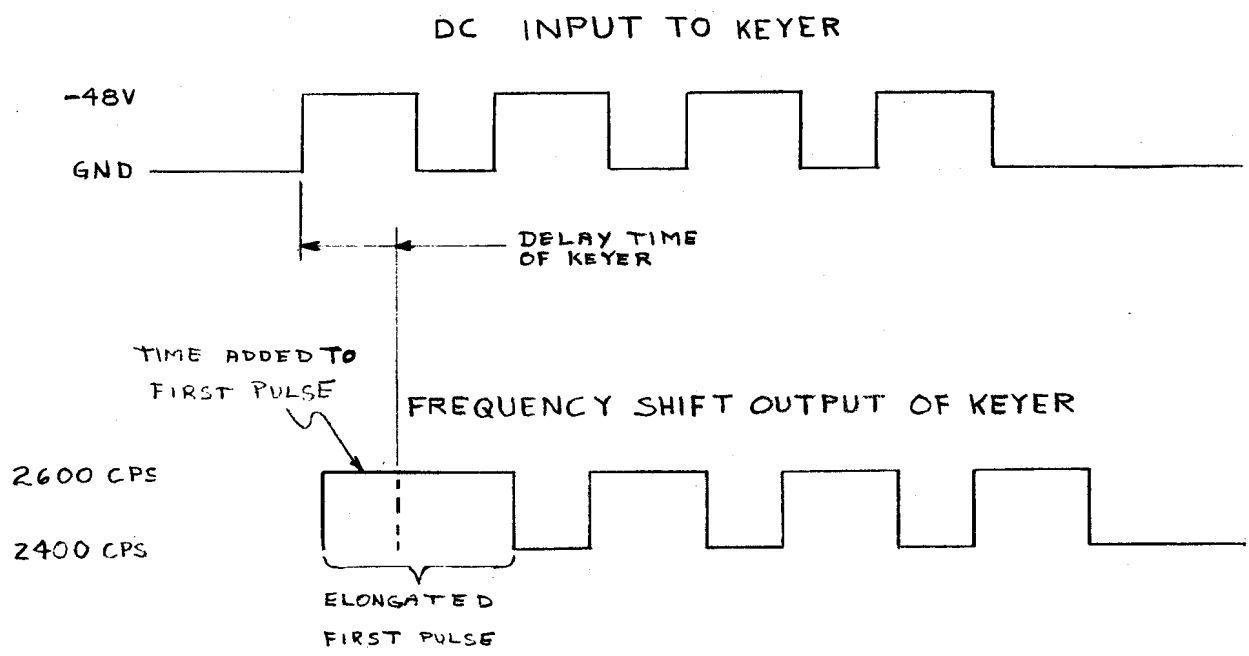


Fig. 3 - Input and Output of Keyer

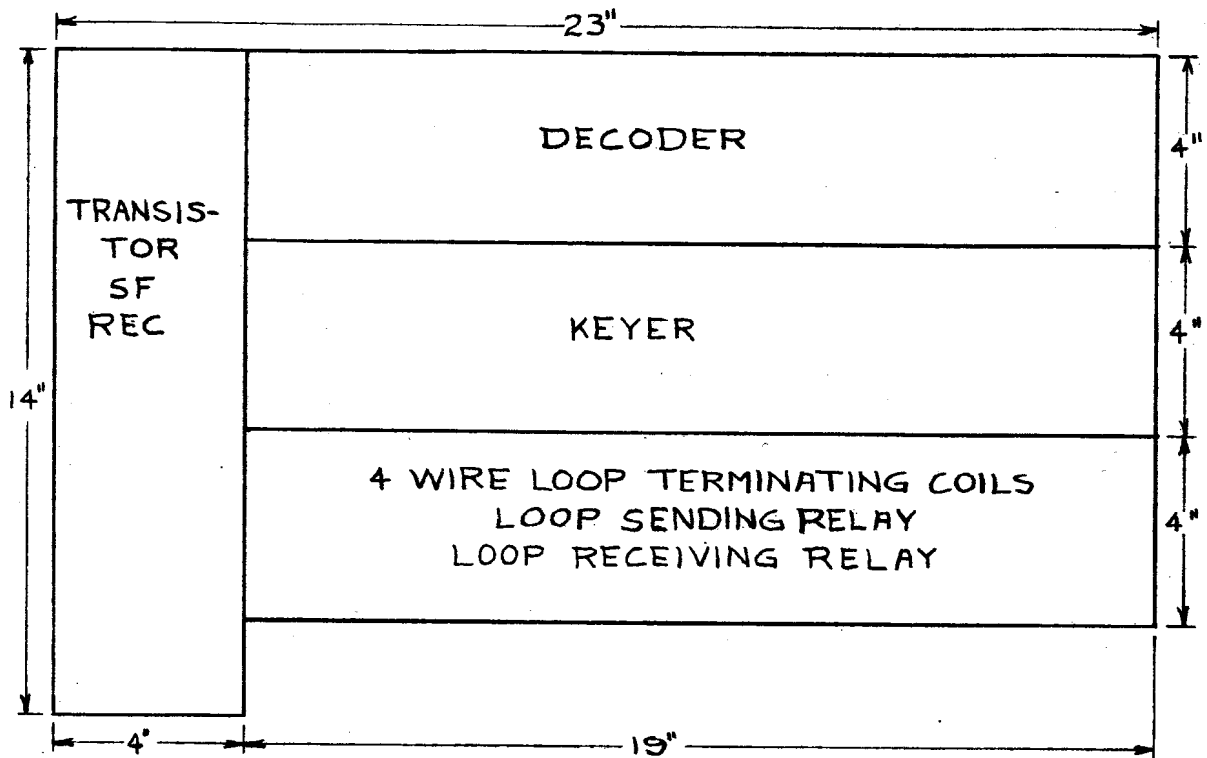


Fig. 4 - Central Office Equipment Arrangement for Loop Signaling When One Loop Is Used

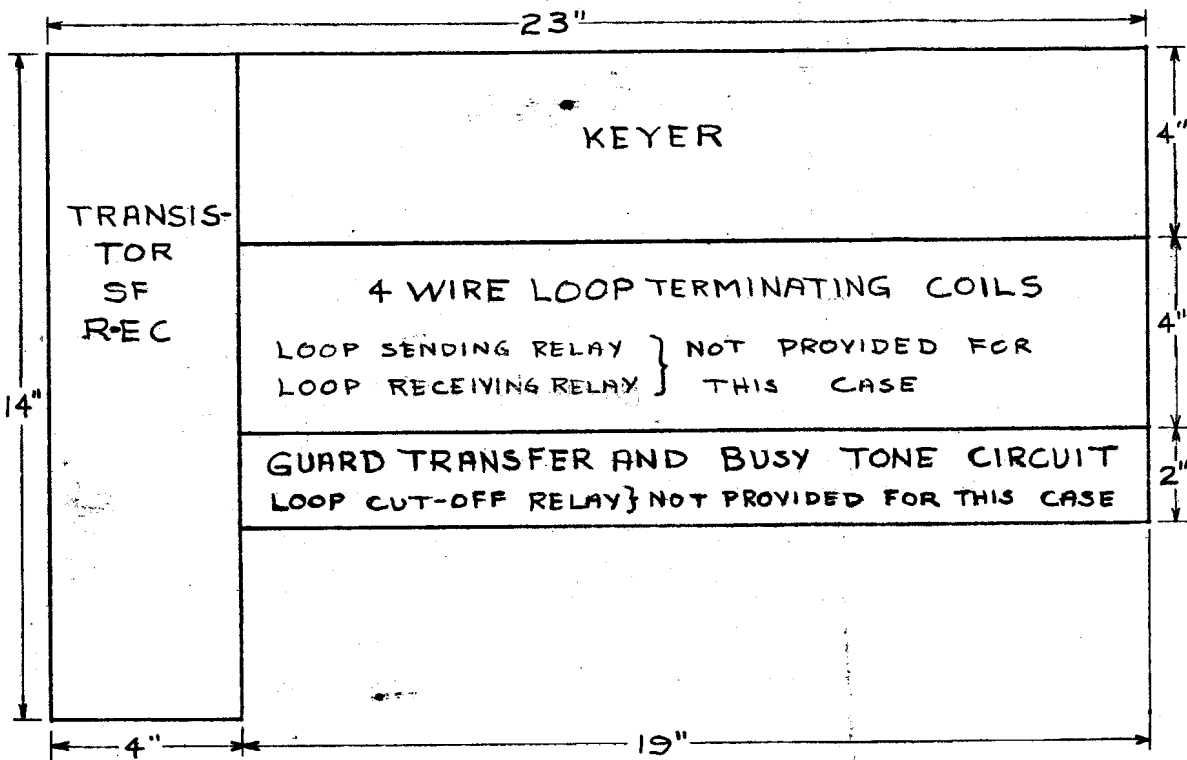


Fig. 5 - Central Office Equipment Arrangement For DX Signaling When One Loop Is Used