tellabs
technical manual
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rev A

practice section 82243/824313

243 Low Speed Data Signaling System
4313 Alarm Station Interface Module

contents

Note: *The* **basic** *243 Low Speed Data Signaling System, which comprises three modules and a prewired, rack-mounted enclosure, is described in* **two separate Tellabs 243 System Practices,** *of which this Practice is one. Specifically, this Practice covers the 4313 Alarm Station Interface Module, which is used at the receiving end of the 243 System in applications where the 4311 Data Conversion Module is used at the transmitting end. The other Practice on the basic 243 System covers the 4311 Data Conversion Module, the 4312 Loop Interface Module, and the 24X Mounting Assembly that houses these modules at the transmitting end.*

Augmenting the three basic System modules are two additional modules **not considered part of the basic 243 System:** *the 4312A Loop Interface Remote Control Module and the 4322 Loop Monitor/Interface Module. These specialized transmitting-end modules are referenced where applicable in the two basic System Practices and are described in detail in* **their own separate Tellabs Practices.**

1. general description

1.01 The 243 Low Speed Data Signaling System (figure 1) provides unidirectional transmission of loop-status signals at rates between 2 and 15 bits per second (bps). Designed primarily to interface with customer-premises alarm systems of the type generally known as McCulloh systems, the 243 System transmits coded alarm signals (generated by McCulloh-type alarm transmitters at a protected location in response, typically, to a fire or intrusion alarm) to an alarm company's central station over dedicated voice-frequency interoffice facilities.

1.02 This Practice section is reissued to cover changes to the 4313 resulting in the Issue 2 version of the module (Tellabs part number **824313**). Unlike its Issue 1 counterpart, the Issue 2 4313 provides a double-fault indication on the 2wire metallic loop to the central alarm station (in addition to a local CO alarm also provided by the Issue 1 4313) if power to the module fails. Also, the Issue 2 4313 does not contain the decoding logic of the Issue 1 module. This is because the Issue 2 4313 is designed specifically for use with transmitting-end 4311 modules of Issue 2 or later, whose output signals, while logic-compatible, are not logic-encoded and thus do not require decoding by the 4313 at the receiving end.

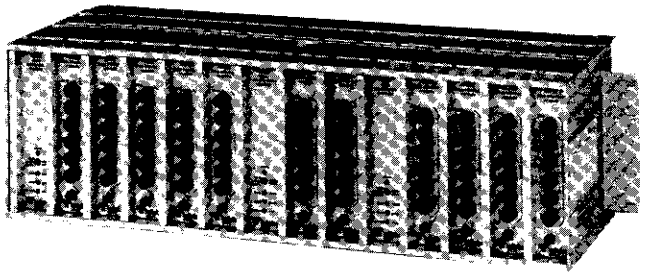


figure 1. 243 Low Speed Data Signaling System (typical configuration)

1.03 The **basic** 243 System comprises four components: Three are Type 10 modules, and the fourth is a prewired, connectorized, rack-mounted enclosure. The three modules are the 4311 Data Conversion Module, the 4312 Loop Interface Module, and the 4313 Alarm Station Interface Module. The enclosure is the Tellabs 24X Mounting Assembly. A single basic 243 System consists of one 4311 module and from one to five associated 4312 modules in a 24X Assembly at the CO serving the alarm-transmitter end of the circuit, plus one 4313 module at the CO serving the alarm-receiver end of the circuit. Unlike the 4311 and 4312, the 4313 does not require a special prewired mounting assembly; see paragraphs 1.12 and 1.13 for details.

1.04 The 4313 module (figure 2) is specifically designed to receive logic-compatible alarm signals transmitted from a 4311 module and to convert these signals into loop-status signals for transmission to an alarm company's central alarm station (CAS). The signals received by the 4313 module originate as follows: At the transmitting end of the circuit, one or more McCulloh-type alarm transmitters at one or more customers' protected

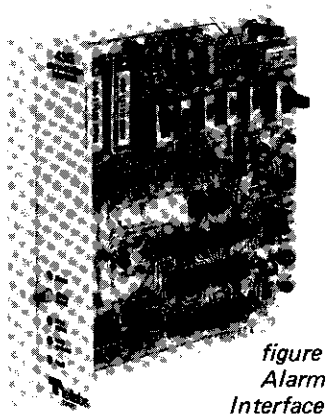


figure 2. 4313 Alarm Station Interface Module

locations are connected in series to a 2wire metallic loop that is terminated on a 4312 Loop Interface Module at the serving CO. (Up to six of these loops can be terminated on one 4312.) To report an alarm condition, an alarm transmitter opens and grounds its metallic loop (at a rate between 2 and 15 bits per second) in a time-coded sequence that identifies the transmitter's location. The 4311 Data Conversion Module receives these loop-open and loop-ground signals from the associated 4312 modules (up to five 4312's may be served by one 4311) and converts them into corresponding logic-compatible output states (see the companion 243/ 4311/4312 Practice for details). These output states are transmitted over two separate, dedicated, voice-frequency interoffice facilities to the CO serving the alarm company's CAS. At this CO, the 4313 Alarm Station Interface Module converts the logic-compatible signals back into exact duplicates of the original loop-open and loop-ground signals for transmission over a 2wire metallic loop to a McCulloh-type alarm receiver at the CAS. Mercury-wetted relays in the 4313 provide chatter-free operation to ensure exact reproduction of the loop-open and loop-ground signals.

1.05 Unlike the alarm-transmitter loops at the transmitting end and the 2wire loop from the 4313 to the CAS at the receiving end, the two separate interoffice transmission facilities need not be metallic. Switch options on the 4313 condition the module to properly receive the logic-compatible signals from the 4311 either directly from metallic facilities or from carrier facilities via data sets (e.g., Tellabs' 3228 Data Set Transmit/Receive Module) or via E&M signaling units.

1.06 In addition to converting the received logic-compatible signals back into duplicates of the original loop-open and loop-ground signals, the 4313 makes provision (via switch option) for increasing the resistance of the 2wire metallic loop to the CAS by 300, 2000, or 4000 ohms. Since loop current is supplied by the CAS, this feature allows the amount of loop current to be controlled to ensure proper operation of the McCulloh receiver's overcurrent detector in the event that an attempt is made to disable the System by shorting the CAS 2wire loop.

1.07 An additional switch option on the 4313 conditions the module to operate with either positive or negative dc supply on the CAS loop. (This dc is supplied by the CAS; see section 2 of this Practice for specific loop current and loop resistance information.)

1.08 The front panel of the 4313 contains four light-emitting diodes (LED's) labeled *loop open, loop ground, alarm,* and *fault.* When logic-compatible signals are being received from the associated 4311 module, the 4313's *loop open* and *loop ground* LED's light for the duration of the **converted** signals, i.e., for the duration of the loop-open and loop-ground signals reproduced by the 4313. When a failure occurs on an interoffice facility, or when an open and/or a ground condition exists on the composite series System loop at the transmitting end, either the *loop open* or *loop ground* LED or both (depending upon the type and location of the fault) light steadily. If the fault exists continuously for more than about 10 seconds, both the *alarm* and *fault* LED's also light steadily, and relay contact closure takes place to activate an external audible alarm at the serving CO. This contact closure also takes place if power to the 4313 fails.

1.09 Similarly, if loop current is absent on the 2wire metallic CAS loop for more than 10 continuous seconds, the 4313's *fault* and *alarm* LED's light continuously, and relay contact closure takes place to activate an audible CO alarm. Regardless of whether an audible CO alarm is initiated in response to a failure on a customer loop, on an interoffice facility, or on the CAS loop, the alarm can be reset by means of an *alarm reset* pushbutton on the 4313's front panel. Depressing this pushbutton also extinguishes the *alarm* LED, but the *fault* LED remains lighted until the System returns to normal.

1.10 An automatic reset feature built into the 4313's fault and alarm logic automatically resets this logic (causing the audible CO alarm to cease and all LED's to extinguish) if a fault is cleared and the System returns to normal for 5 continuous seconds. This feature eliminates the need for manually resetting the audible CO alarm when temporary faults of short duration occur.

1.11 The 4313 operates on filtered, ground-referenced −44 to −56Vdc input. Maximum current requirement is 50mA.

1.12 A Type 10 module, the 4313 normally mounts in one position of a Tellabs Type 10 Mounting Shelf, versions of which are available for relay rack and apparatus case installation. In relay rack applications, up to 12 modules can be mounted across a 19-inch rack, while up to 14 modules can be mounted across a 23-inch rack. In either case, 6 inches of vertical rack space is used.

1.13 Because the 4313 shares the same connector-pin arrangement as all other 243-System modules, it can also be mounted in the Tellabs 24X Issue 2 Mounting Assembly (or in either of that Assembly's predecessors: the 24X Issue 1 [also known as the 242] Mounting Assembly or the 244 Mounting Assembly) if this is more convenient. The 24X Issue 2 Assembly is available in two versions: the 24XA, which houses 12 modules and mounts in a 19-inch relay rack, and the 24XB, which houses 14 modules and mounts in a 23-inch relay rack. Each version occupies 6 inches of vertical rack space. For additional information on the 24X Issue 2 Assembly and its predecessors as used with the 243 System, please refer to the companion 243 System/4311 and 4312 Module Practice, section 82243/824311/814312.

2. application

2.01 The 243 Low Speed Data Signaling System is designed for unidirectional transmission of low-speed loop-status signals. While its primary application is to interface customer-premises alarm systems of the type generally known as McCulloh systems, the 243 System may also be used for transmitting any low-speed loop-status signals between 2 and 15 bits per second (bps). Rates higher than 15bps are likely to result in distorted data, and rates lower than 2bps may be recognized as a fault by the 243 System.

Note: *As stated above, the most frequent application of the 243 System is to interface a McCulloh-type alarm system. For this reason, as well as for clarity and brevity, the 243 System and, in particular, the 4313 Module, will be covered in terms of this specific application both in the remainder of section 2 and in sections 3* **(installation)** *and 7* **(testing and troubleshooting)** *of this Practice. The information provided in these sections, however, will apply equally when the 243 System is used in other applications. Should you require additional application information or assistance in installing, testing, or troubleshooting the 243 System, please contact Tellabs Customer Service at your Tellabs Regional Office or at our U.S. or Canadian Headquarters.*

2.02 The McCulloh systems that interface the 243 System are typically used to provide fire and/or intrusion alarms in business, industrial, and residential applications. A typical **basic** System arrangement is shown in figure 3.

2.03 The 4313 Alarm Station Interface Module is used for receipt and conversion of logic-compatible signals at the receiving end of a **basic** 243 System. These signals originate at the transmitting end of the circuit as loop-open and loop-ground alarm signals generated by the McCulloh system's alarm transmitters on the customer loops. The loop-open and loop-ground signals are numerically coded (normally as a sequence of one to four digits) to identify the exact locations of the transmitters from which they originate. The loop-open and loop-ground signals are received by the 243 System's 4311 Data Conversion Module. The 4311 converts loop-open signals into logic-compatible output signals designated *N1* and converts loop-ground signals into logic-compatible signals designated *G1*. These N1 and G1 signals are transmitted from the 4311 module to the 4313 module over their own separate, dedicated interoffice facilities similarly designated *N1* and *G1* according to the signals they carry.

2.04 At the receiving end of the circuit, the 4313 module receives the N1 and G1 signals and converts them back into exact duplicates of the original loop-open and loop-ground alarm signals. These duplicated loop-open and loop-ground signals are then transmitted over a 2wire metallic loop to the McCulloh system's alarm receiver at the CAS. Figure 4 shows loop conditions and timing sequences for all signals generated by the McCulloh system and the 243 System during normal operation, i.e., with no faults present and with the 4311 module's N1 and G1 outputs optioned for normal (not inverted) signaling states as described below.

Note: *In applications where the interoffice facilities are metallic, and also in applications where only one CO serves both the transmitting end of the System and the CAS via metallic loops, conversion of loop-open and loop-ground signals into logic-compatible output states is generally unnecessary (un-*

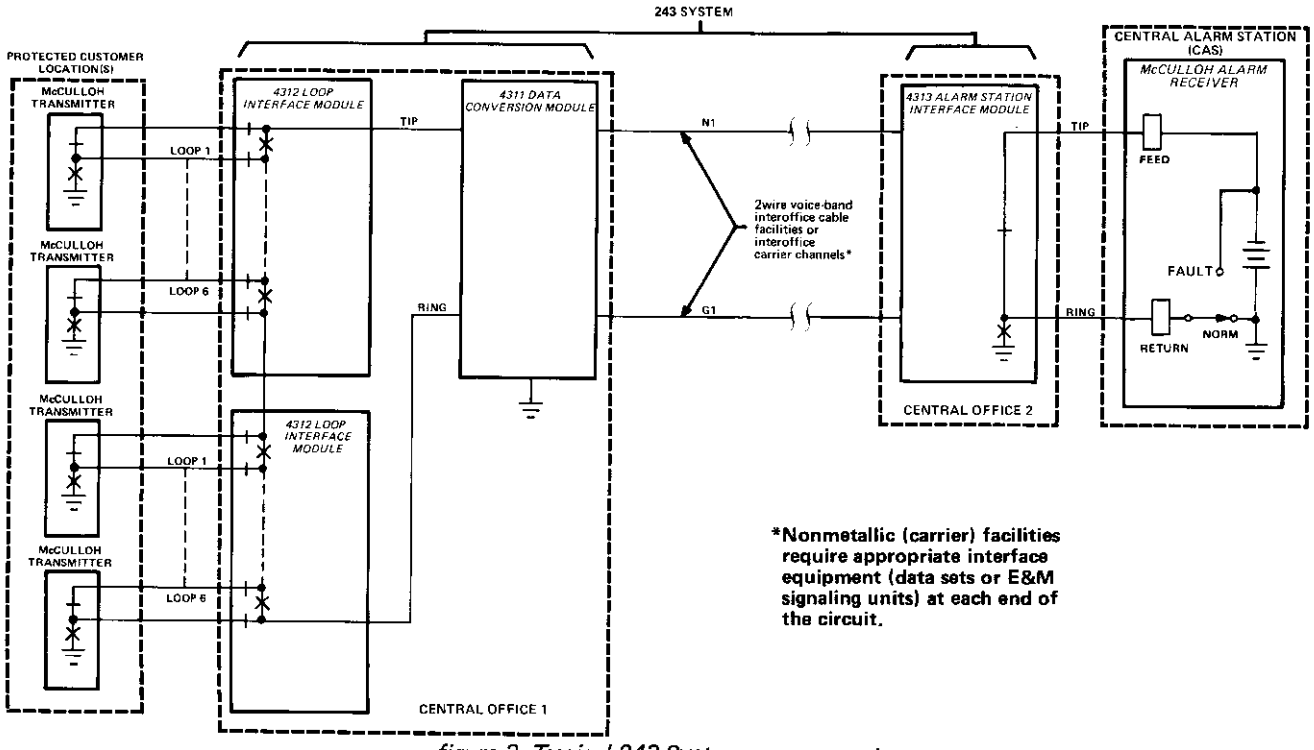


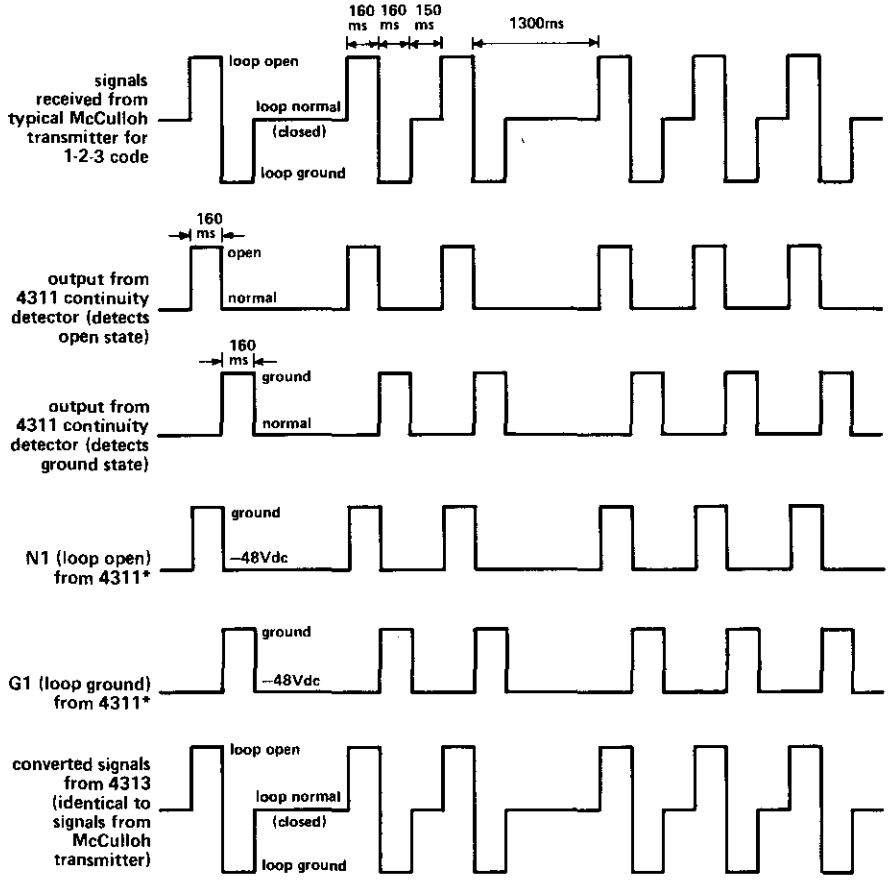
figure 3. Typical 243 System arrangement

less, for example, the facilities or loops are so long that adequate loop current cannot be supplied). For such metallic-only applications not requiring logic-compatible output states, the 4322 Loop Monitor/Interface Module can be used instead of the 4311 (or instead of the 4311 and one 4312). The 4322 terminates three customer loops in exactly the same manner as the six-loop 4312 and also monitors the entire composite System loop for open and ground alarm signals. When the 4322's monitoring section detects such signals, it passes them unchanged toward the CAS. Because the 4322 does not convert the alarm signals into logic-compatible output states, a 4313 is not required for conversion back into loop-open and loop-ground signals at the receiving end. Also, because the 4322 itself terminates three customer loops, the need for an associated 4312 module may be eliminated. For these reasons, Tellabs recommends use of the 4322 for greatest economy in many applications where only metallic facilities and/or loops are involved and no need for carrier compatibility is anticipated. See the 4322 Module Practice for details.

2.05 The N1 and G1 outputs of the 4311 module at the System's transmitting end each comprise two separate logic-compatible signaling states. These two states represent the idle (no signals present) and active (signaling occurring) states of the composite loop. A switch option on the 4311 allows the idle and active signaling states of both the N1 and G1 outputs to be inverted for 243-System compatibility with various types of interoffice facilities and associated interface equipment, as detailed in paragraphs 2.06 through 2.09. Reference to figures 5a through 5c will be helpful when reading these paragraphs. These figures show typical 243-System applications involving both metallic and nonmetallic interoffice facilities, and indicate all applicable signaling states of the 4311 and 4313 modules and, where present, those of associated facility interface devices.

2.06 In applications where the 243 System (i.e., the 4311 module at the transmitting end and the 4313 module at the receiving end) interfaces metallic interoffice facilities directly, and also in applications where the 243 System interfaces nonmetallic interoffice facilities via data sets (e.g., Tellabs' 3228 Data Set modules), the 4311 module is optioned for *normal* N1 and G1 outputs. In this normal signaling format, both the N1 and G1 outputs of the 4311 are at −48Vdc when idle and at ground when active. In applications where the 243 System interfaces nonmetallic interoffice facilities via E&M signaling units, the 4311 is optioned for *inverted* N1 and G1 outputs. In this inverted signaling format, both the N1 and G1 outputs of the 4311 are at ground when idle and at −48Vdc when active. These *inverted* N1 and G1 output states are the M-lead input states that are required by E&M signaling units for conventional tone-on-when-idle, tone-off-when-active facility signaling. The capability of optioning the 4311 module's N1 and G1 outputs for *inverted* signaling states is highly advantageous in applications involving nonmetallic interoffice facilities interfaced via E&M signaling units. The reasons for this are twofold:

(1) When the signaling states of the 4311's N1 and G1 outputs are *inverted*, a failure of one or both carrier channels causes the 4313 at the receiving end to generate an appropriate alarm indication. If the signaling states of the 4311's N1 and G1 outputs were not inverted, the E&M signaling units at the receiving end would produce ground outputs during both normal idle conditions and carrier-failure conditions. Thus, carrier-failure conditions



*4311 module optioned for normal N1 and G1 outputs.

figure 4. 243 System signaling: timing sequence for 1, 2, 3 code

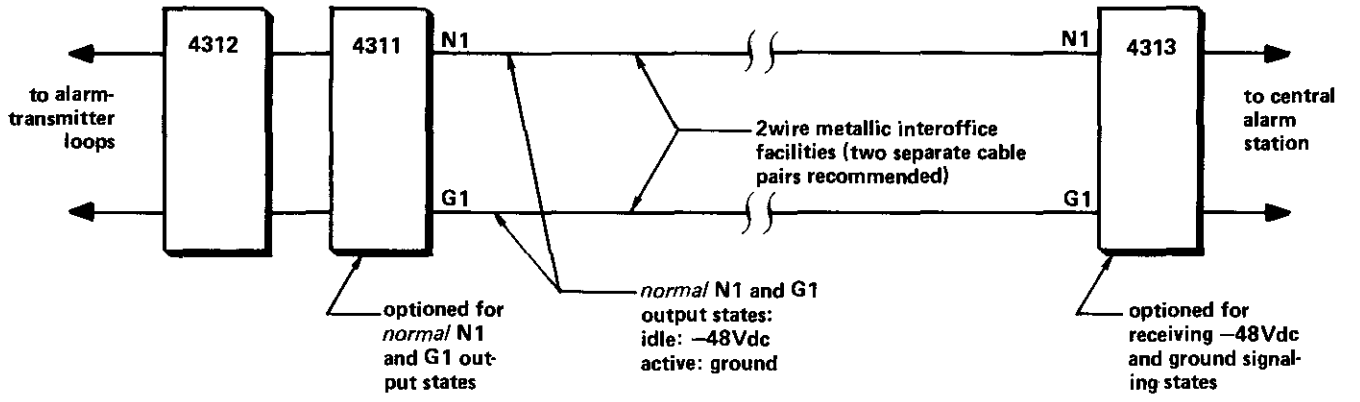


figure 5a. Metallic interoffice facilities

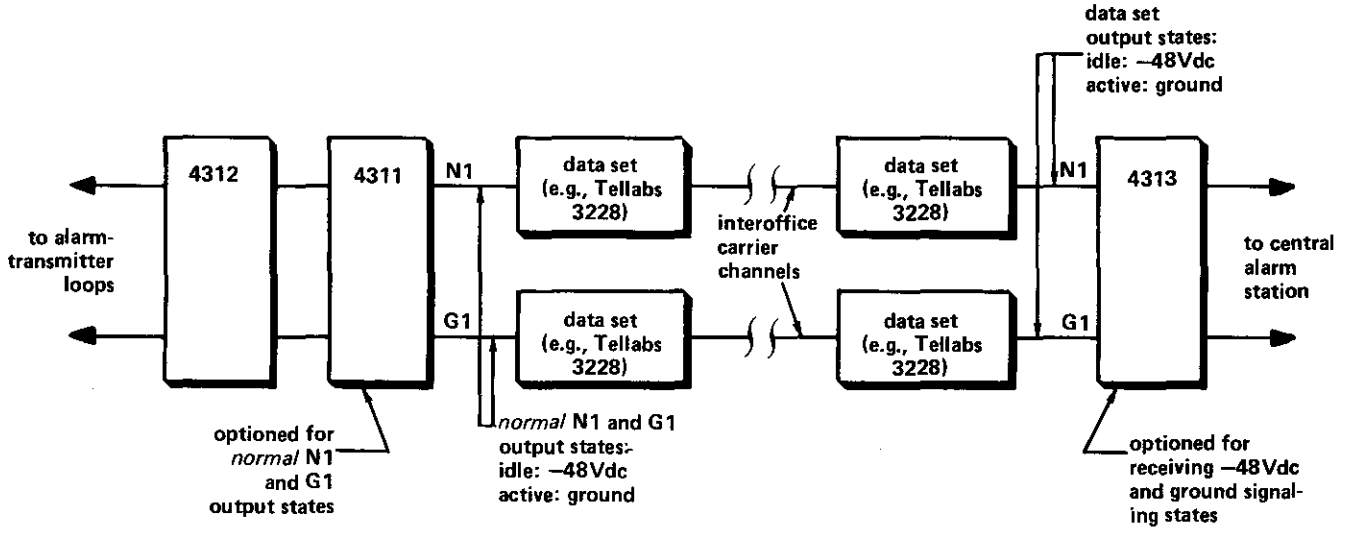


figure 5b. Nonmetallic interoffice facilities with data set interface

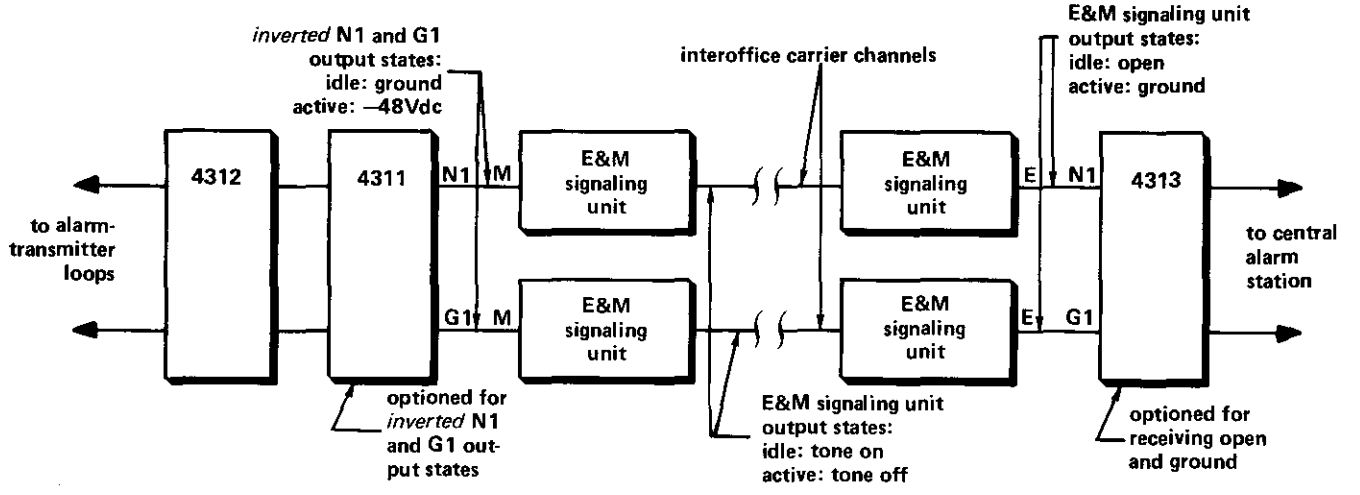


figure 5c. Nonmetallic interoffice facilities with E&M signaling unit interface

figure 5. 243 System signaling over metallic and nonmetallic interoffice facilities

would appear normal to the 4313, and no alarms would be generated.

(2) Because the signaling states of the 4311's N1 and G1 outputs can be inverted via a switch option on the module itself, the need to install pulse-link repeaters between the 4311 and the transmitting-end E&M signaling units to perform this signaling-state inversion is eliminated.

2.07 Because the idle and active signaling states at the N1 and G1 outputs of the transmitting-end 4311 module can be optioned for either of two formats – normal or inverted, as described above –

the received idle and active signaling states at the N1 and G1 inputs of the 4313 module will consequently be in either of two formats. The 4313 can be conditioned via switch option to accept whichever of these two input-signaling-state formats exists in its particular application, as described in paragraph 2.08.

2.08 In applications where the 4311 module at the transmitting end of the circuit is optioned for normal N1 and G1 outputs, the N1 and G1 inputs to the 4313 (received either directly from metallic interoffice facilities or from data sets that interface nonmetallic interoffice facilities) are at −48Vdc when idle and at ground when active. Thus, in these applications, the 4313 must be optioned to accept −48Vdc and ground inputs. In applications where the 4311 module at the transmitting end of the circuit is optioned for inverted N1 and G1 outputs, the N1 and G1 inputs to the 4313 (received from E&M signaling units that interface nonmetallic interoffice facilities) are open when idle and at ground when active. (These are conventional E-lead output states.) Thus, in these applications, the 4313 must be optioned to accept open and ground inputs.

2.09 Under normal idle conditions (no alarm signal transmission and no faults) and when the independent N1 and G1 interoffice facilities are metallic, up to 10mA of current flows on each interoffice facility. The direction of current flow depends upon how the signaling states of the 4311 module's N1 and G1 outputs are optioned. When the 4311's N1 and G1 signaling states are *normal,* current flows from the 4313 toward the 4311. When the 4311's N1 and G1 signaling states are *inverted,* current flows from the 4311 toward the 4313.

2.10 Whenever an N1 signal is transmitted by the remote 4311, the 4311's logic causes the current to be turned off in the N1 interoffice facility. At the receiving end, the 4313 detects this loss of current as an N1 signal and converts it back into a loop-open signal. The *loop ground* LED on the 4313 lights and the module's N relay operates to open the CAS 2wire loop for the duration of the loop-open signal. Similarly, whenever a G1 signal is transmitted by the remote 4311, the 4311's logic causes the current to be turned off in the G1 interoffice facility. At the receiving end, the 4313 detects this loss of current as a G1 signal and converts it back into a loop-ground signal. The *loop ground* LED on the 4313 lights and the module's G relay operates to ground the CAS 2wire loop for the duration of the loop-ground signal.

2.11 Interoffice transmission between the 4311 at the transmitting end and the 4313 at the receiving end occurs in what may be termed a "fail-safe" mode. Because the N1 and G1 signals are transmitted on separate and independent interoffice facilities, a failure of either the N1 or G1 facility does not affect transmission on the other. Therefore, at least part of the alarm information reaches the receiving end. Failure of either facility causes the corresponding *loop open* or *loop ground* LED on the 4313 to light. If the failure persists for more than 10 continuous seconds, the 4313's *fault* and *alarm* LED's light and a relay in the module operates to activate an audible CO alarm.

2.12 A single 4313 module can serve more than one transmitting location, i.e., more than one 4311 module and its one to five associated 4312 modules. For details on such an arrangement, please refer to the 243 System/4311 and 4312 Module Practice. Please note that in any System arrangement, the telephone company whose CO serves the transmitting end is **not** responsible for lost alarm signals due to clashes (signals arriving simultaneously from two different locations).

2.13 Power to the 2wire CAS loop is provided by the CAS. Recommended loop current is 5 to 15mA; typical loop voltage is −130Vdc through loop-sensing relay coils. An option switch on the 4313 allows the use of either positive or negative dc supply (negative is more commonly used). The System will not operate if the wrong polarity is selected, and the System's fault logic will be activated.

2.14 Maximum external resistance of the CAS loop should not exceed 2000 ohms. An additional 300, 2000, or 4000 ohms of series resistance (150, 1000, or 2000 ohms on each side of the 2wire loop) can be introduced via switch options on the 4313 module. This allows the amount of loop current to be controlled, thereby ensuring proper operation of the overcurrent detector in the McCulloh receiver at the CAS should an attempt be made to disable the System by shorting the CAS 2wire loop.

fault conditions

2.15 The 4313 module recognizes any of the following as a fault condition: any received N1 or G1 signal from the associated 4311 module that lasts 10 seconds or longer (such a signal indicates the presence of one or more faults on the composite System loop terminated on the 4311), any abnormal condition of either the N1 or G1 interoffice facility that lasts 10 seconds or longer, or any open or ground condition of the CAS loop that lasts 10 seconds or longer (with one exception, described below). Because the 4313 is "transparent" to signal transmission (as are the transmitting-end modules of the 243 System), the 4313 will transmit information during all fault conditions under which signals would reach the McCulloh receiver if the 243 System were not present between the McCulloh transmitters and receiver (i.e., if the McCulloh transmitters and receiver were connected directly).

fault and alarm indications: customer-loop and interoffice-facility faults

2.16 Immediately upon recognition of either a valid N1 signal, an open fault on the composite System loop at the transmitting end, or an open fault (see note) on the N1 interoffice facility, the 4313's N relay operates for the duration of the signal or fault, lighting the front-panel *loop open* LED for the same duration. Similarly, immediately

upon recognition of either a valid G1 signal, a ground fault on the composite System loop, or an open fault (see note) on the G1 interoffice facility, the 4313's G relay operates for the duration of the signal or fault, lighting the front-panel *loop ground* LED for the same duration. However, as stated above, the 4313 does not recognize any of these conditions as actual faults until they have persisted for 10 continuous seconds. At that time, the 4313's fault and alarm logic is activated, lighting the front-panel *fault* and *alarm* LED's and operating the module's alarm relay to provide contact closure for initiating an audible CO alarm. The audible alarm can be silenced by momentarily depressing the *alarm reset* pushbutton on the 4313. This also causes the *alarm* LED to extinguish. The other lighted LED's, however, remain lighted for the duration of the fault.

Note: *If the transmitting-end 4311 module is optioned for* **normal** *N1 and G1 outputs, ground as well as open faults on the N1 and G1 facilities will produce the results described.*

fault and alarm indications: CAS-loop faults

2.17 Any open condition that exists for 10 continuous seconds on either the tip (feed) or ring (return) side of the CAS loop activates the 4313's fault and alarm logic, causing the *fault* and *alarm* LED's (but **not** the *loop open* LED) to light and operating the module's alarm relay to provide contact closure for initiating an audible CO alarm. Any ground condition that exists on the tip side of the CAS loop similarly activates the 4313's fault and alarm logic, causing the *fault* and *alarm* LED's (but **not** the *loop ground* LED) to light and operating the module's alarm relay. As is the case when customer-loop and interoffice-facility faults activate the 4313's fault and alarm logic, the audible CO alarm can be silenced by momentarily depressing the 4313's *alarm reset* pushbutton. This also causes the *alarm* LED to extinguish, but the *fault* LED remains lighted for the duration of the fault. Only in cases where a prolonged ground condition exists on the ring side of the CAS loop is the 4313 unable to detect the fault. Thus, in this fault condition only, the 4313's fault and alarm logic is not activated, and neither LED indications nor alarm relay operation is provided. This is not a problem, however, because such a fault condition will immediately be detected by the McCulloh receiver at the CAS, and appropriate alarm indications will be generated at that location.

Note: *Under normal conditions (no signaling occurring and no faults present anywhere in the circuit), the power-feed switch of the McCulloh receiver at the CAS (see figure 3) is in the normal position. As a result, the McCulloh receiver supplies battery to only the tip (feed) side of the CAS loop, and the ring (return) side remains at ground potential. When one or more open and/or ground faults occur anywhere in the circuit, the McCulloh receiver's power-feed switch immediately changes to the fault position. As a result, the McCulloh receiver supplies battery to* **both** *sides of the CAS loop. Unless* **all** *alarm transmitters,* **both** *interoffice facilities, or* **both** *sides of the CAS loop are completely disabled, this power-feed change ensures that at least* **some** *alarm signals will reach the McCulloh receiver during fault conditions.*

signal transmission during customer-loop and interoffice-facility faults

Note: *Before reading paragraphs 2.18 through 2.20, you should be familiar with the various loop-open and loop-ground conditions that constitute* **single, multiple,** *and* **double** *faults in the 243 System. If you are not familiar with these fault types, please refer to section 2 of the 243 System/4311 and 4312 Module Practice, which defines these three fault types and provides an extensive description of 243-System operation during each. Table 1 of this Practice, which contains a comprehensive summary of all possible faults throughout the 243 System, may also be helpful for a better understanding of paragraphs 2.18 through 2.20. In addition to specific composite-loop, interoffice-facility, and CAS-loop fault conditions, table 1 lists the resultant LED indications on both the 4311 and 4313 modules and also lists the corresponding signals received by the McCulloh reciever at the CAS.*

2.18 Because the 243 System is completely transparent to signal transmission, the ability of the 4313 to receive and convert signals is unaffected by faults that occur either on the transmitting-end customer loops or on the N1 and G1 interoffice facilities. Thus, during all customer-loop and interoffice-facility fault conditions under which N1 or G1 signals are able to reach the 4313, the 4313 will convert the received signals back into loop-open or loop-ground signals in the usual manner for transmission over the CAS loop to the McCulloh receiver.

Note: *If the capability of isolating customer-loop faults from the CO where the 4313 module is located is desired, this capability can be provided for any 243 System through use of 4312A Loop Interface Remote Control Modules in place of standard 4312 Loop Interface Modules at the System's transmitting end. Although the 4312 allows faulty customer loops to be quickly and easily isolated, this must be done locally by depressing pushbuttons on the 4312 module itself and on the associated 4311 module. The 4312A, however, contains relay circuitry that allows this fault isolation to be performed remotely. Because of the added circuitry, however, the 4312A can terminate a maximum of only four customer loops (the 4312's maximum is six). See the 4312A Module Practice for details.*

signal transmission during single CAS-loop faults

2.19 With respect to the CAS loop, a *single fault* is defined as one type of fault — either open or ground — occurring on one side — either tip (feed) or ring (return) — of the CAS loop. A single CAS-loop fault disables only the one side of the loop on which it is located. Thus, signal transmission between the 4313 and the McCulloh receiver can still take place during single CAS-loop faults, but only

no.	CAS alarm receiver switch position	fault condition (open and/or ground)					CO visible indication								signals received at CAS †	note
			interoffice facilities*		CAS loop		4311 LED's				4313 LED's					
		customer loop	N1	G1	tip (feed) side	ring (return) side	alarm**	loop open	loop ground	current monitor	loop open	loop ground	fault	alarm**		
1	NORMAL	–	–	–	–	–	off	off	off	off	off	off	off	off	O and G	system normal
2	FAULT***	open	–	–	–	–	on	on	off	on	on	off	on	on	G	signaling loop open
3	FAULT***	–	–	–	–	open	off	off	off	off	off	off	on	on	O	CAS return open
4	FAULT***	–	–	–	open	–	off	off	off	off	off	off	on	on	G	CAS feed open
5	FAULT***	open	–	–	–	open	on	on	off	on	on	off	on	on	X	double open
6	FAULT***	–	–	–	open	open	off	off	off	off	off	off	on	on	X	double open
7	FAULT***	open	–	–	open	–	on	on	off	on	on	off	on	on	G	multiple open
8	FAULT***	ground	–	–	–	–	on	off	on	off	off	on	on	on	O	gnd on signaling loop
9	FAULT***	–	–	–	–	ground	off	off	off	off	off	off	off	off	O	gnd on CAS return
10	FAULT***	–	–	–	ground	–	off	off	off	off	off	off	on	on	O	ground on CAS feed
11	FAULT***	–	–	–	ground	ground	off	off	off	off	off	off	on	on	X	double ground
12	FAULT***	ground	–	–	ground	–	on	off	on	off	off	on	on	on	X	double ground
13	FAULT***	ground	–	–	–	ground	on	off	on	off	off	on	on	on	O	multiple ground
14	FAULT***	open and ground	–	–	–	–	on	on	on	on	on	on	on	on	$\bar{O}$ or $\bar{G}$	double fault
15	FAULT***	open	–	–	–	ground	on	on	off	on	on	off	on	on	X	double fault
16	FAULT***	ground	–	–	open	–	on	off	on	off	off	on	on	on	X	double fault
17	FAULT***	–	–	–	open	ground	off	off	off	off	off	off	on	on	X	double fault
18	FAULT***	–	–	–	–	open and ground	off	off	off	off	off	off	on	on	O or G	double fault on one side of CAS loop
19	FAULT***	–	–	–	open and ground	–	off	off	off	off	off	off	on	on	G or O	double fault on one side of CAS loop
20	FAULT***	–	–	–	ground	open	off	off	off	off	off	off	on	on	X	double fault
21	FAULT***	ground	–	–	–	open	on	off	on	off	off	on	on	on	O	open on CAS return, gnd on signaling loop
22	FAULT***	open	–	–	ground	–	on	on	off	on	on	off	on	on	G	ground on CAS feed, open signaling loop
23	FAULT***	–	open or ground	–	–	–	off	off	off	off	on	off	on	on	G	failure of N1 facility
24	FAULT***	–	–	open or ground	–	–	off	off	off	off	off	on	on	on	O	failure of G1 facility

*It is assumed that the interoffice facilities reproduce the signaling states of the 4311 module's N1 and G1 outputs at the respective inputs of the associated 4313 module.

**The *alarm* LED's extinguish after the alarm is manually cleared.

***During fault conditions, power is fed to both sides of the CAS loop by the McCulloh receiver at the CAS.

†During double faults, signals can be received only from those McCulloh transmitters which, when activated, can maintain loop-current continuity through their ground relays.

KEY:
CAS: central alarm station
O: open; N relay in CAS loop is activated during signal transmission
G: ground; G relay in CAS loop is activated during signal transmission
$\bar{O}$: no open; N relay in CAS loop is deactivated during signal transmission
$\bar{G}$: no ground; G relay in CAS loop is deactivated during signal transmission
X: no signal received at CAS

table 1. 243 System fault conditions and indications

over the nonfaulty side of the CAS loop. Furthermore, any signals transmitted during single CAS-loop faults are of only one type – loop open or loop ground – as described below:

(A) When an open fault exists on the ring side of the CAS loop, the 4313 transmits loop-ground signals over the tip side.

(B) When an open fault exists on the tip side of the CAS loop, the 4313 transmits loop-ground signals over the ring side.

(C) When a ground fault exists on the ring side of the CAS loop, the 4313 transmits loop-open signals over the tip side.

(D) When a ground fault exists on the tip side of the CAS loop, the 4313 transmits loop-open signals over the ring side.

signal transmission during multiple and double CAS-loop faults

2.20 With respect to the CAS loop, a *multiple fault* is defined as one type of fault – either open or ground – occurring in two or more places on either the tip (feed) side, the ring (return) side, or both sides of the CAS loop. A *double fault* is defined as two faults of different types – open and ground – occurring on one or both sides of the CAS loop. If a multiple or double fault involves both the tip and ring sides of the CAS loop, both sides of the loop are disabled and no signal transmission between the 4313 and the McCulloh receiver can take place. If, however, a multiple or double fault involves only one side of the CAS loop, only that side of the loop is disabled, and signal transmission can take place between the 4313 and the McCulloh receiver over the nonfaulty side. As is true during single faults, any signals transmitted during a multiple or double fault involving only one side of the CAS loop are of only one type – loop open or loop ground – as described below:

(A) Signal transmission when a multiple fault exists on one side of the CAS loop is identical to signal transmission when a single fault exists on that side of the loop. See paragraph 2.19, items A through D, for details.

(B) When a double faults exists on one side of the CAS loop, the type of signal (loop open or loop ground) transmitted over the nonfaulty side depends upon the locations of the individual open and ground faults on the faulty side. A detailed description of all possible configurations of double faults of this type and of the resultant CAS-loop signal transmission is beyond the scope of this Practice.

power failure to 4313

2.21 When power to the 4313 module fails, signal transmission between the module and the CAS ceases. However, upon loss of power, a normally energized relay in the 4313 releases. This results in both an audible CO alarm and a double-fault indication on the 2wire CAS loop. Thus, personnel at the CO and also at the CAS will be aware of any loss of power to the 4313.

3. installation

Caution: *Because the 4313 contains mercury-wetted relays, this module should always be held in an upright position and tapped gently on a hard surface before installation. The module should then be kept in an upright position until it is installed.*

inspection

3.01 The 4313 Alarm Station Interface Module should be visually inspected upon arrival in order to find possible damage incurred during shipment. If damage is noted, a claim should immediately be filed with the carrier. If stored, the module should be visually inspected again prior to installation.

mounting

3.02 The 4313 module mounts in one position of the Tellabs Type 10 Mounting Shelf, which is available in configurations for both relay rack and apparatus case installation. The module plugs physically and electrically into a 56-pin connector at the rear of the Type 10 Shelf. (If it is convenient, the 4313 can also be mounted in one position of the Tellabs 24X Issue 2 Mounting Assembly or in one position of either of that Assembly's predecessors: the 24X Issue 1 [also known as the 242] Mounting Assembly or the 244 Mounting Assembly.)

installer connections

3.03 Before making any connections to the Type 10 Mounting Shelf, make sure that power is **off** and modules are **removed**. Modules should be put into place only **after** they are properly optioned and **after** wiring is completed.

3.04 Table 2 lists external connections to the 4313 module. All connections are made via wire wrapping at the 56-pin connector at the rear of the module's mounting shelf position. Pin numbers are found on the body of the connector.

connect:	to pin:
CAS-LOOP TIP*	41
CAS-LOOP RING	47
N1	7
G1	13
N.O. ALARM (normally open alarm relay contacts)	9 and 43
−48V (−48Vdc filtered input battery)	35
GND (ground)	17

*Tip lead must be at greater potential than ring lead.

table 2. External connections to 4313

options

3.05 Optioning of the 4313 consists of conditioning the module for operation with either positive or negative CAS-loop dc supply, introducing additional loop resistance to control CAS-loop current and thereby ensure proper operation of the McCulloh receiver's overcurrent detectors, and conditioning the module to accept the specific idle and active signaling states that make up the N1 and G1 input signals. These options are selected as described in paragraphs 3.06 through 3.08. Option switch locations on the 4313's printed circuit board are shown in figure 6.

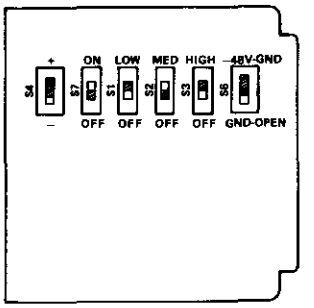


figure 6. 4313 option switch locations

3.06 Condition the 4313 for operation with either positive or negative (with respect to ground) dc supply on the CAS loop as follows: Determine the polarity of the CAS-loop dc supply either by contacting the CAS for this information or by measuring the voltage (with respect to ground) on the tip side of the CAS loop. If the CAS-loop supply voltage is positive, set switch *S4* to the + (positive) position. If the supply voltage is negative, set *S4* to the − (negative) position.

3.07 Set option switches *S1* through *S3* to introduce additional series resistance into the CAS loop (see paragraph 2.14). Depending upon the requirements of the CAS overcurrent detectors (this information must be provided by CAS personnel), switches *S1* through *S3* are set as follows: *S1* to *LOW* and *S2* and *S3* to *OFF* if 300 ohms of additional loop resistance is required; *S2* to *MED* and *S1* and *S3* to *OFF* if 2000 ohms of additional loop resistance is required; or *S3* to *HIGH* and *S1* and *S2* to *OFF* if 4000 ohms of additional loop resistance is required. Please note that two of these three switches must be set to *OFF* at all times for proper operation of the module. In applications where information on the loop-current requirements of the CAS overcurrent detectors is unavailable, **always start with 4000 ohms** of additional CAS-loop resistance to provide maximum current limiting. A lower resistance value may be selected later, if necessary.

3.08 Condition the 4313 to properly receive signals from the N1 and G1 interoffice facilities by setting switches *S6* and *S7* as indicated in table 3. (Switch *S6* controls the feeding technique for the module's current detectors, and switch *S7* causes open N1 and G1 signaling states received from the associated data sets or E&M signaling units to be changed to −48Vdc signaling states.)

Note: *If your 243 System interfaces carrier interoffice facilities via E&M signaling units, please take special notice of the statements marked by asterisks (*) at the bottom of table 3.*

3.09 After all options are selected and verified, no further optioning or alignment of the 4313 module is required.

4. circuit description

4.01 This circuit description is intended to familiarize you with the 4313 Alarm Station Interface Module for engineering and application purposes only. Attempts to troubleshoot the 4313 internally are not recommended. Troubleshooting procedures should be limited to those prescribed in

if interoffice facilities are:	and if 243 System interfaces interoffice facilities via:	4311's N1 and G1 outputs should be optioned for:	4313's N1 and G1 inputs will be:	therefore, option 4313's S6 and S7 as follows:	
				S6	S7
metallic	direct interface	normal signaling states*	idle: –48Vdc active: ground	–48-GND	OFF
nonmetallic	data sets with –48Vdc and ground outputs (e.g., Tellabs' 3228)	normal signaling states*	idle: –48Vdc active: ground	–48-GND	OFF
nonmetallic	data sets with open and ground outputs	normal signaling states*	idle: open active: ground	–48-GND	ON
nonmetallic	E&M signaling sets	inverted signaling states** if alarm indication is desired when facility fails	idle: open active: ground	–48-GND	ON
nonmetallic	E&M signaling sets	normal signaling states* if no alarm indication is desired when facility fails	idle: ground active: open	GND-OPEN	OFF

*The **normal** signaling states of the 4311 module's N1 and G1 outputs are –48Vdc when idle and ground when active. When the 243 System interfaces nonmetallic interoffice facilities via E&M signaling units and normal N1 and G1 output states are selected on the 4311 module, the E&M signaling unit at the receiving end will produce a ground output not only during idle conditions but also when the associated carrier channel fails. Thus, a carrier failure will appear to the 4313 as a normal idle condition, and no alarm indication will be provided.

The **inverted signaling states of the 4311 module's N1 and G1 outputs are ground when idle and –48Vdc when active. When the 243 System interfaces nonmetallic interoffice facilities via E&M signaling units and inverted N1 and G1 output states are selected on the 4311 module, the E&M signaling unit at the receiving end will produce an open output during idle conditions and a ground output when the associated carrier channel fails. Thus, a carrier failure will not appear to the 4313 as a normal idle condition, and an appropriate alarm indication will be provided.

table 3. Option switch S6 and S7 settings for proper N1 and G1 signal reception by 4313 module

section 7 of this Practice. Refer to the block diagram, section 5 of this Practice, as an aid in following the circuit description.

4.02 The *N1* and *G1 current detectors* in the 4313 receive N1 and G1 signals from the 4311 Data Conversion Module at the transmitting end over the N1 and G1 interoffice facilities, respectively. Opto-isolators in these detectors have a current threshold of 4.0mA; thus, when current in the N1 or G1 interoffice facility drops below 4.0mA, the current drop is recognized as a signal. The *N1* and *G1 current detectors* convert these signals into logic-compatible signals for output to the *N1 and G1 signal conversion logic* and the *fault and alarm detection logic.*

4.03 The *N1 and G1 signal conversion logic* receives the logic-compatible N1 and G1 signals from the *N1* and *G1 current detectors* and converts them into exact duplicates of the loop-open and loop-ground signals generated by the McCulloh transmitters. Timers in the *N1 and G1 signal conversion logic* continuously monitor the duration of the incoming N1 and G1 signals. If either signal remains in the active state for more than 10 continuous seconds, the 4313's *fault and alarm logic* is activated (see paragraph 4.06).Reliability of the *N1 and G1 signal conversion logic* is ensured through use of precision timing and logic elements (monostable multivibrators and latches).

4.04 The loop-open and loop-ground signals reproduced by the *N1 and G1 signal conversion logic* are fed to the *N* and *G relay drivers* to activate the *N* and *G relays*, respectively. These are mercury-wetted relays whose chatter-free operation ensures that the original loop-open and loop-ground signals are reproduced exactly over the metallic CAS loop. The 4313's front-panel *loop open* and *loop ground* LED's light whenever signals are present at the module's N1 and G1 inputs, respectively.

4.05 The 4313's *continuity detectors* monitor each side of the CAS loop (tip and ring) for current (see note). When loop current is absent, opto-isolators in the *continuity detectors* generate logic-compatible signals that activate the module's *fault and alarm logic.*

Note: *The McCulloh receiver supplies negative or positive dc power to the CAS loop, which is terminated on the 4313. The 4313 is conditioned to operate with either polarity by means of option switch* S4. *The CAS normally sources between 5 and 15mA of current, and option switches* S1 *through* S3 *on the 4313 are used to insert additional loop resistance to limit loop current to this range. Half of this added resistance is inserted on the tip side and half on the ring side of the CAS loop. Total resistance of the CAS loop,* **not including** *that added via switch* S1, S2, *or* S3, *must not exceed 2000 ohms.*

4.06 The *fault and alarm logic* receives its inputs from either the *N1* and *G1 current detectors* or the *continuity detectors.* If any of these inputs remains in the active state for more than 10 continuous seconds, the *fault and alarm logic* provides an output to set the *alarm latch* and light both the *fault* and *alarm* front-panel LED's. If all active inputs return to their inactive states for approximately 5 seconds, the *fault and alarm logic* resets the

alarm latch and the *N1 and G1 signal conversion logic.*

4.07 The *alarm latch,* if set, can be manually reset by depressing the *alarm reset* pushbutton on the front panel. This resets (i.e., opens) the contacts of the *alarm relay* and extinguishes the *alarm* LED. The *fault* LED, however, remains lighted for the duration of the fault condition.

4.08 The 4313's integral *power supply* generates (from –48Vdc input) the V_{SS} and V_{DD} voltages for the module's logic sections.

6. specifications

N1 and G1 interoffice facility conductor resistance
5000 ohms maximum on each facility

N1 and G1 interoffice facility current requirement
4.0mA minimum on each facility

idle and active signaling states at N1 and G1 inputs to 4313
–48Vdc and ground *or* open and ground *or* ground and open

longitudinal voltage on N1 and G1 interoffice facilities
4Vrms maximum on each facility

external central alarm station (CAS) loop resistance
2000 ohms maximum, not including that added via option switches on 4313

CAS-loop current requirement
5.0 to 15mA, supplied by alarm receiver at CAS

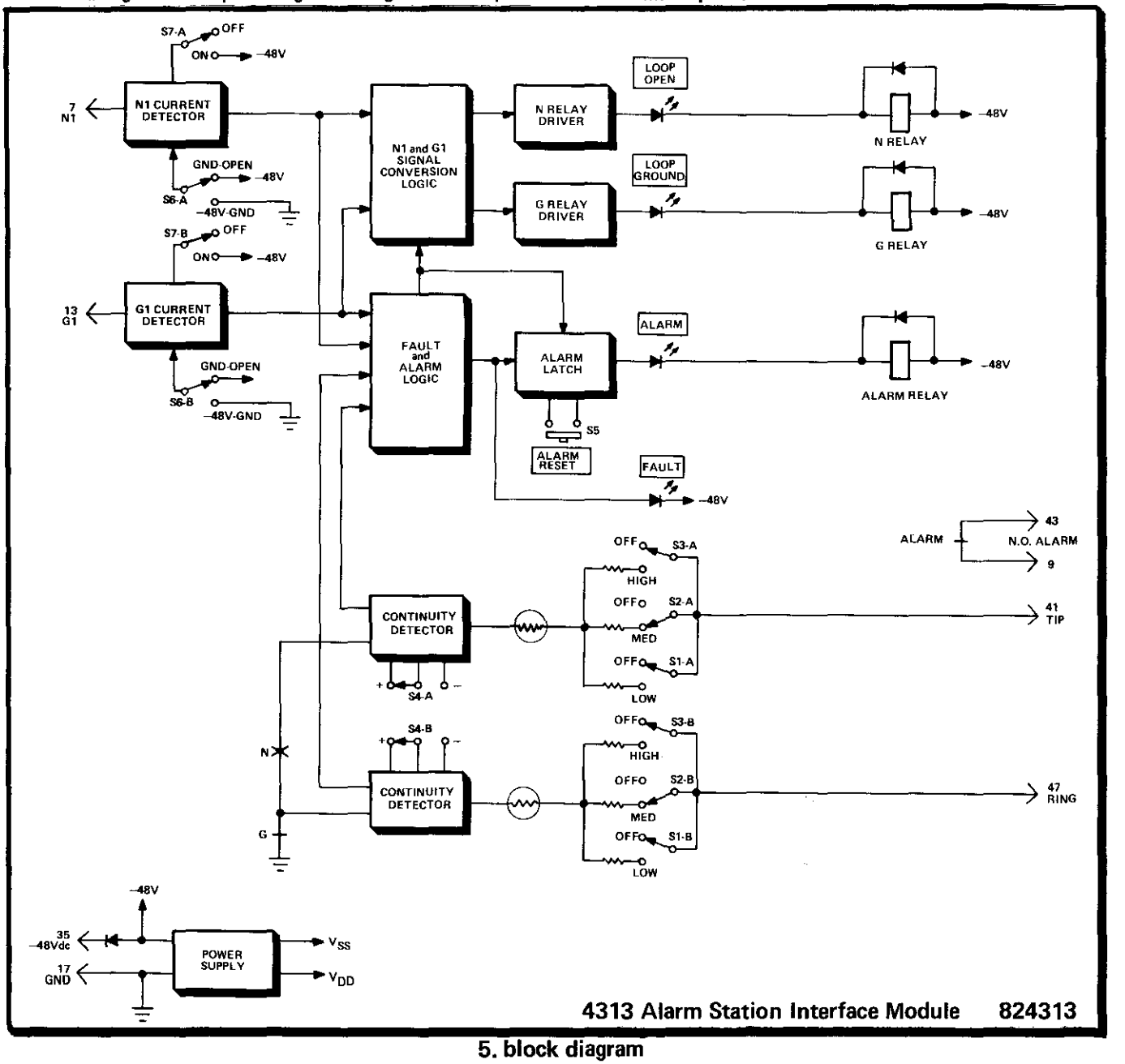
CAS-loop supply voltage polarity
either positive or negative, ground referenced, accommodated via switch option on 4313 module

output states (from 4313) on CAS loop
open and/or ground

alarm logic activation time
approximately 10 seconds

alarm logic reset time
approximately 5 seconds

input power requirements
–44 to –56Vdc, filtered, ground referenced; 60mA maximum plus current on N1 and G1 facilities



4313 Alarm Station Interface Module 824313

5. block diagram

operating environment
20° to 130°F (–7° to 54°C), humidity to 95% (no condensation)

dimensions
5.58 inches (14.17cm) high
1.42 inches (3.61cm) wide
5.96 inches (15.14cm) deep

weight
6.5 ounces (184 grams)

mounting
relay rack or apparatus case via one position of Tellabs Type 10 Mounting Shelf; can also be mounted in one position of Tellabs 24X Issue 2, 24X Issue 1 (also known as 242), or 244 Mounting Assembly

7. testing and troubleshooting

7.01 The Testing Guide Checklist in this section may be used to assist in the installation, testing, or troubleshooting of the 243 Low Speed Data Signaling System at the receiving end of the circuit. The Checklist identifies the most common types of trouble conditions and lists possible causes. In general, the most expeditious method of isolating trouble is the substitution of known good modules for suspected defective modules.

7.02 It is strongly recommended that no internal (component-level) testing or repairs be attempted on the 243 System's Mounting Assembly or modules. Unauthorized testing or repairs may void your Tellabs warranty.

7.03 If a situation arises that is not covered in the Checklist, contact Tellabs Customer Service at your Tellabs Regional Office or at our Lisle, Illinois, or Mississauga, Ontario, Headquarters. Telephone numbers are as follows:

US central region: (312) 969-8800
US Northeast region: (412) 787-7860
US southeast region: (305) 645-5888
US western region: (702) 827-3400
Lisle Headquarters: (312) 969-8800
Mississauga Headquarters: (416) 624-0052

7.04 If a 4313 Alarm Station Interface Module (or any other equipment used in the 243 System) is diagnosed as defective, the situation may be remedied by either *replacement* or *repair and return*. Because it is the more expedient method, the *replacement* procedure should be followed whenever time is a critical factor (e.g., service outages, etc.).

replacement

7.05 If a defective device is encountered, notify Tellabs via letter (see addresses below), telephone (see numbers above), or twx (910-695-3530 in the USA, 610-492-4387 in Canada). Be sure to provide all relevant information, including the 8XXXXX part number that indicates the issue of the device in question. Upon notification, we shall ship a replacement to you. If the warranty period of the defective device has not elapsed, the replacement will be shipped at no charge. Package the defective device in the replacement's carton, sign the packing list included with the replacement, and enclose it with the defective device (this is your return authorization). Affix the preaddressed label provided with the replacement to the carton being returned, and ship the equipment prepaid to Tellabs.

repair and return

7.06 Return the defective equipment, shipment prepaid, to Tellabs (attn: repair and return).

in the USA: Tellabs Incorporated
4951 Indiana Avenue
Lisle, Illinois 60532

in Canada: Tellabs Communications Canada, Ltd.
1200 Aerowood Drive, Unit 39
Mississauga, Ontario, Canada L4W 2S7

Enclose an explanation of the malfunction. Follow your company's standard procedure with respect to administrative paperwork. Tellabs will repair the equipment and ship it back to you. If the equipment is in warranty, no invoice will be issued.

testing guide checklist

Note: *Additional troubleshooting procedures are provided in companion 243 System/4311 and 4312 Module Practice.*

trouble condition	possible cause (in order of likelihood)
System inoperative (signals not received; LED's lighting improperly or not at all)	1) Power connection faulty or open ☐. Verify power to 4313 by measuring voltage between pins 35 (–48Vdc) and 17 (ground) ☐. 2) Faulty LED's ☐.
loop open and *alarm* and/or *fault* LED's always lighted	1) Open fault on signaling loop ☐. 2) Open fault on N1 interoffice facility ☐. 3) Switch *S6* or *S7* improperly set ☐.
loop ground and *alarm* and/or *fault* LED's always lighted	1) Ground fault on signaling loop ☐. 2) Open fault on G1 interoffice facility ☐. 3) Switch *S6* or *S7* improperly set ☐.
alarm and/or *fault* LED lighted	1) Option switch *S4* improperly set for polarity of CAS supply ☐. 2) Power failure in CAS loop ☐. 3) Current in CAS loop too low ☐. 4) Switches *S1, S2,* and/or *S3* improperly set ☐.
loop open, loop ground, and *alarm* and/or *fault* LED's lighted	1) At transmitting end, 4311 module not receiving power (module may have been removed from System) or faulty☐. 2) Failure of N1 and G1 interoffice facilities for more than 10 seconds ☐.

tellabs

243/4311/4312 and 243/4313 Addendum
1 August 1982

This addendum to Practice section 82243/824311/814312 dated 1 June 1981 and to Practice section 82243/824313 dated 1 January 1982 is issued for the following reasons:

A. To correct table 3 of the 243/4311/4312 Practice and table 1 of the 243/4313 Practice. (These tables are identical.)
B. To correct paragraph 2.21 of the 243/4311/4312 Practice.
C. To correct table 5 of the 243/4311/4312 Practice.
D. To provide installation-test information for the 4313 module.
E. To provide additional information on 243-System operation when double-fault conditions exist on customer loops.

correction to table 3 (243/4311/4312 Practice) and table 1 (243/4313 Practice):
In table 3 of the 243/4311/4312 Practice and in table 1 of the 243/4313 Practice, for fault number 3, change "O" to "G" in the signals received at CAS column.

correction to paragraph 2.21 of 243/4311/4312 Practice:
In paragraph 2.21 of the 243/4311/4312 Practice, several words that end the fourth sentence and begin the last sentence are missing. The fourth sentence (which begins on line 8 of paragraph 2.21) and the fifth (last) sentence should read as follows (the missing words are in bold face):

The remaining faulty loops can be isolated in a similiar manner by working backward, removing the bypasses from all previously bypassed loops and reconnecting these loops in reverse order. When all faulty loops are isolated, the 24X Assembly's bypass switches for all 4312 module positions should be reset to *OFF* and the 4312 modules reinserted into the Assembly to restore System operation.

correction to table 5 of 243/4311/4312 Practice:
In table 5 of the 243/4311/4312 Practice, for module position 4, lead designation G1, change the 56-pin module connector pin no. in the rightmost column from 41 to 13.

installation test for 4313 module:
Installation-test information for the 4313 module does not appear in the 243/4313 Practice. The easiest way to test the 4313 is to install the entire 243 System, connect the N1 and G1 interoffice facilities, and perform the installation test in paragraph 3.13 of the 243/4311/4312 Practice while personnel at the 4313's location verify that the front-panel LED indications on the 4313 are the same as those on the 4311 module at the transmitting end. If proper transmitting-end (4311 and 4312) operation is established but the LED indications on the 4313 are different or nonexistent, check power and wiring to the 4313, switch-optioning of the 4313, and the integrity of the N1 and G1 interoffice facilities. If these items are checked but proper operation of the 4313 is still not established, replace the module and retest.
Note: *If the 4313 interfaces the N1 and G1 facilities via a pair of Tellabs 3228 Data Set modules, the 4313 can be tested locally by depressing the* test *pushbutton on each of the 3228's and observing the LED indications on the 4313. Depressing the* test *pushbutton on the* N1 facility's 3228 *causes the 4313's* loop open *LED to light. Holding that 3228's* test *pushbutton depressed for 10 seconds causes the 4313's* fault *and* alarm *LED's to light as well. Depressing the test pushbutton on the* G1 facility's *3228 causes the 4313's* loop ground *LED to light. Holding that 3228's* test *pushbutton depressed for 10 seconds causes the 4313's* fault *and* alarm *LED's to light as well.*

additional information on System operation during customer-loop double faults:
In table 3 of the 243/4311/4312 Practice and table 1 of the 243/4313 Practice, fault number 14 (a double fault) is described as an open fault and a ground fault on a customer loop. Actually, several variations of customer-loop double faults exist, depending upon the locations of the two faults. They can be on the same side of a loop (with the ground fault toward the transmitter and the open fault toward the 4312 module or vice versa), on opposite sides of a loop, or on two different loops. Faults A through D in figure A of this addendum represent double faults with the two faults located on the same side of one loop. Fault E represents a double fault with the two faults located on opposite sides of a loop. Faults F through H represent double faults with the two faults located on two different loops.
Note: *Please be aware that, for simplicity, figure A shows only a six-loop System, i.e., a System containing only one 4312 module. For larger Systems, the last customer loop will not be terminated on the same 4312 module as the first. Thus, when double faults involving two customer loops occur, customer loops terminated on* more than one *4312 module may be affected, depending upon the locations of the two faults.*

For faults A through D in figure A, signals will be received from McCulloh transmitter 1 because only

one side of customer loop 1 is faulty. Signals will also be received from loops 2 through 6, all of which are nonfaulty.

Both subvariations of fault E (open on T and ground on R, and vice versa) will, however, disable loop 1 entirely because both sides of the loop are faulty. Signals will be received, though, from customer loops 2 through 6, which are nonfaulty.

Both subvariations of fault F will disable all signal transmission from loops 2 and 3, which lie entirely between the two faults. Signals will, however, be received from loops 1 and 4, both of which have one side outside of the two faults. Signals will also be received from loops 5 and 6, which are nonfaulty.

Both subvariations of fault G will disable all transmission from loops 1 through 4 because both sides of all four loops lie inside the two faults. Signals will, however, be received from loops 5 and 6, which are nonfaulty.

The only type of customer-loop double fault that will disable all signal transmission is fault H. Both subvariations are shown: open on T of the first customer loop and ground on R of the last customer loop, and ground on T of the first loop and open on R of the last loop. Both sides of all customer loops lie within the two faults; thus, no signal transmission can take place.

double fault	number of McCulloh alarm transmitters from which signals are received
A	all
B	all
C	all
D	all
E	all except that on whose loop the double fault exists
F	all except those lying *between* the two faults on the composite loop (for this double fault, signals *will* be received from those transmitters on whose loops the faults are located)
G	all except those lying *between* the two faults on the composite loop (for this double fault, signals *will not* be received from those transmitters on whose loops the faults are located)
H	none

Summary table for figure A

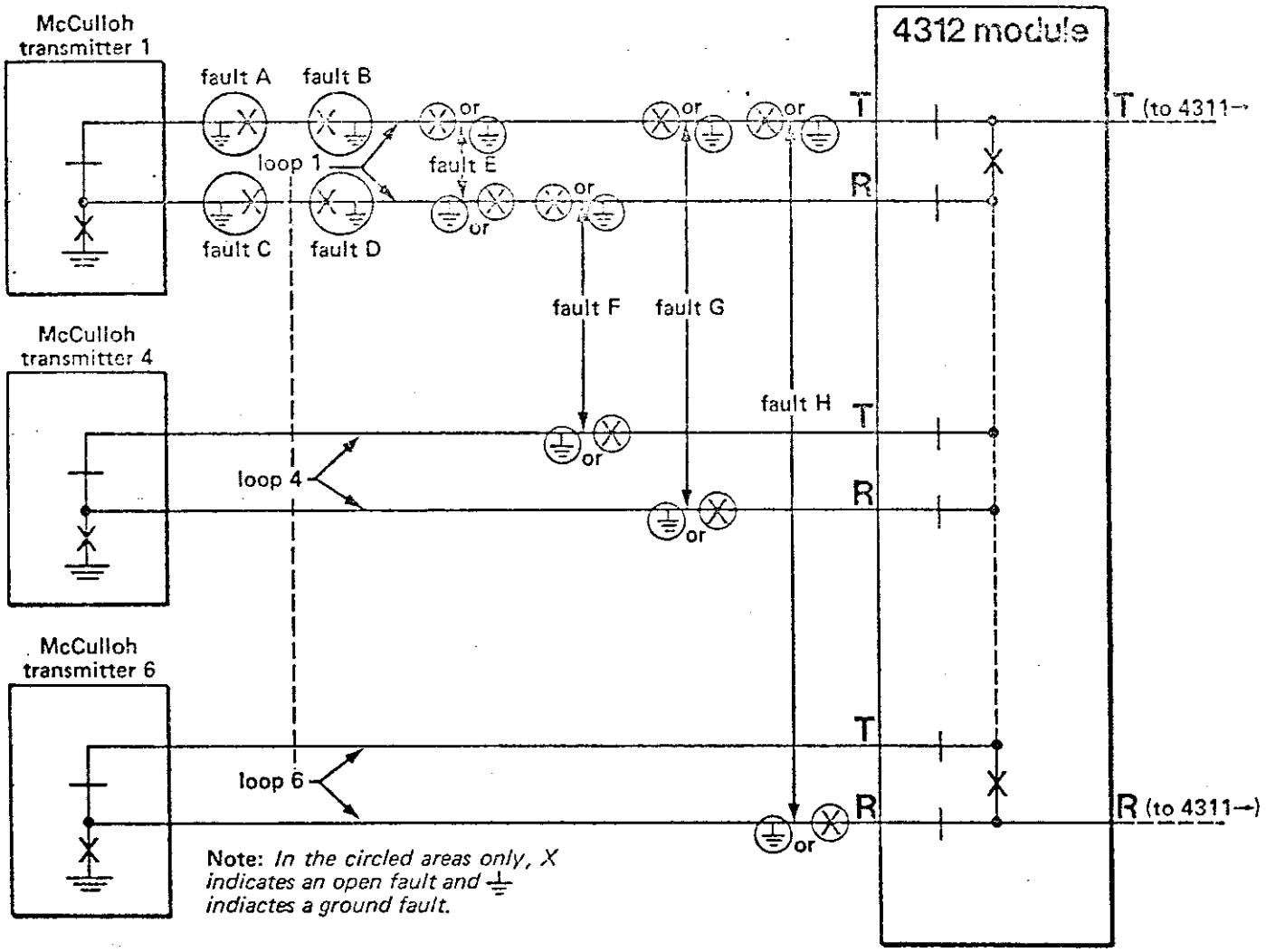


figure A. Basic variations of customer-loop double faults (six-loop System shown)