

## 3228 Data Set Transmit/Receive Module

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### 1. general description

1.01 The 3228 Data Set Transmit/Receive module (figure 1) facilitates the transfer of low-speed data pulses or level information between remote locations and a central site over a 2wire voice-frequency transmission facility. This type of data is commonly encountered in alarm and supervisory signal-monitoring applications. The 3228 serves up to eight independent data channels and uses a frequency-shift-keying (FSK) data transmission format compatible with the Bell System 202 FSK format.

1.02 This Practice section is reissued to cover the Issue 2 version of the 3228 module (Tellabs part number 823228). The Issue 2 module differs from its Issue 1 counterpart through the addition of an integral sealing-current source and also through the provision of a DIP switch for prescription output-level control in the transmit mode in place of the Issue 1's continuously adjustable potentiometer. In addition, the front-panel *fac* opening jack on the Issue 2 3228 faces the facility. (On the Issue 1 3228, it faces the module.)

1.03 A unidirectional data set, the 3228 can be switch-optioned to function either as a data-transmit device (with eight input channels) at the originating end of a circuit or as a data-receive device (with eight output channels) at the receiving end of a circuit. When optioned as a transmit data set, the 3228 scans its eight input data channels at a scanning rate that accommodates data-transfer rates up to 30 baud. Single-ended voltage levels (referenced to ground) detected at the module's inputs are converted into binary data values, which are then transmitted as an asynchronous serial data word. When optioned as a receive data set, the 3228 demultiplexes received asynchronous serial data to its eight single-ended output channels at data-transfer rates up to 30 baud. A front-panel *xmt* LED lights when the 3228 is optioned for the transmit mode and remains unlighted when the 3228 is optioned for the receive mode.

1.04 In the transmit mode, the output level of the 3228's transmitted FSK voice-frequency signals is adjustable from -15 to 0dBm in 1dB increments via a four-position DIP switch on the module's

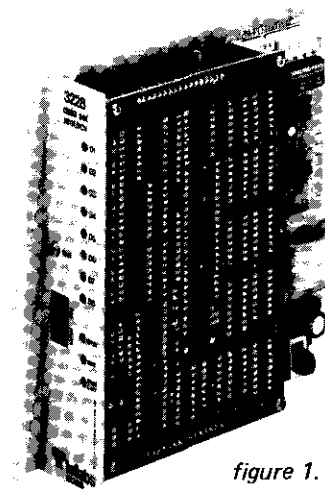


figure 1. 3228 Data Set Transmit/Receive module

printed circuit board. In the receive mode, the 3228 can accommodate any input level between +2 and -30dBm.

1.05 For compatibility with various types of transmission facilities, the 3228 can be switch-optioned to provide balanced 1200-, 600-, or 150-ohm terminating impedance at its 2wire facility port. In applications where the facility is metallic, the module can be optioned to supply 20mA of internally generated sealing current at the 2wire facility port. The sealing-current option includes a "ZAP" feature, which provides a momentarily higher amount of current when the option is initially activated to eliminate existing oxidation or corrosion on the facility. A front-panel *seal curr* LED lights when the sealing-current option is activated and current is flowing.

1.06 The states of the 3228's eight data channels are indicated by individual front-panel LED's. These LED's, labeled *D1* through *D8*, light when their respective data channels are active and extinguish when their respective data channels are inactive. In either the transmit or receive operating mode, the 3228 can be switch-optioned so that either normal or inverted data-channel voltage levels define the module's active and inactive logic states.

1.07 When the 3228 is optioned for transmit operation, the rate at which it scans its data channels can be controlled via switch option. Normally, the 3228's data-channel scanning rate allows it to detect and transmit input data signals between 0 and 30 pulses per second (pps). This scanning rate can be limited, if necessary, so that the module can detect and transmit input data signals between 0 and 15pps only.

1.08 Another switch option used only in the transmit mode either provides internal battery reference for the 3228's data channels (as required in ground-closure alarm applications; see paragraph 2.06) or removes this internal reference if external battery reference is supplied.

1.09 Whenever a transmit-mode 3228 fails to transmit a serial data word for more than 1 second or whenever a receive-mode 3228 fails to receive a valid serial data word for more than 1 second, the module's front-panel *error* LED lights. Normally, all of the module's eight data channels are forced to the active state upon detection of such an error. However, the 3228 can be switch-optional so that, when an error is detected, each data channel remains at the last valid state which existed for that channel prior to detection of the error. The 3228's error-condition responses are automatically removed when the problem is cleared and normal data transfer resumes.

1.10 A front-panel *test* pushbutton allows all data channels to be manually forced to the active state for testing purposes. In addition, two front-panel bantam-type test jacks on the module's 2wire facility side facilitate alignment and maintenance activities. One jack is an opening jack facing the module; the other is a monitoring jack that bridges the module's 2wire facility port.

1.11 The 3228 contains an internally regulated power supply that permits operation on -22 to -56Vdc filtered input. Maximum current requirements are 95mA in the transmit mode and 125mA in the receive mode, plus an additional 20mA (in either mode) when the sealing-current option is activated and current is flowing. Surge protection is provided at the 2wire facility port. Reverse-battery protection and transient-limiting circuitry are provided in the module's internal power-supply circuitry.

1.12 A Type 10 module, the 3228 mounts in one position of a Tellabs Type 10 Mounting Shelf or in one position of a Tellabs 24X Mounting Assembly. The Type 10 Shelf is available in several versions 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. The 24X Assembly is available in two versions: the 24XA, which houses 12 modules and mounts in a 19-inch rack, and the 24XB, which houses 14 modules and mounts in a 23-inch rack. The 24X Assembly and rack-configured Type 10 Shelves each occupy 6 inches of vertical rack space.

1.13 The 3228 module can also be mounted in any of Tellabs' unwired Apparatus Cases designed to accommodate Type 10 modules. These include the single-module 1911 and 1912, the two-module 1913, and the four-module 1914 Apparatus Cases, all of which are designed for wall mounting primarily at customer locations.

## 2. application

2.01 The 3228 Data Set Transmit/Receive module is designed to serve up to eight independent data channels in applications where low-speed data pulses and/or level information is transmitted over a 2wire voice-frequency transmission facility. A unidirectional data set, the 3228 can be conditioned via switch option to serve either data-transmit or data-receive applications. (Bidirectional data applications therefore require four 3228's, two at each end of the circuit. One 3228 at each end must be optioned for the transmit mode, the other for the receive mode.) The 3228 can accommodate data-transfer rates up to 30 baud and uses an FSK data transmission format compatible with the Bell System 202 FSK format. Figure 2 illustrates the transmit and receive operational modes of the 3228.

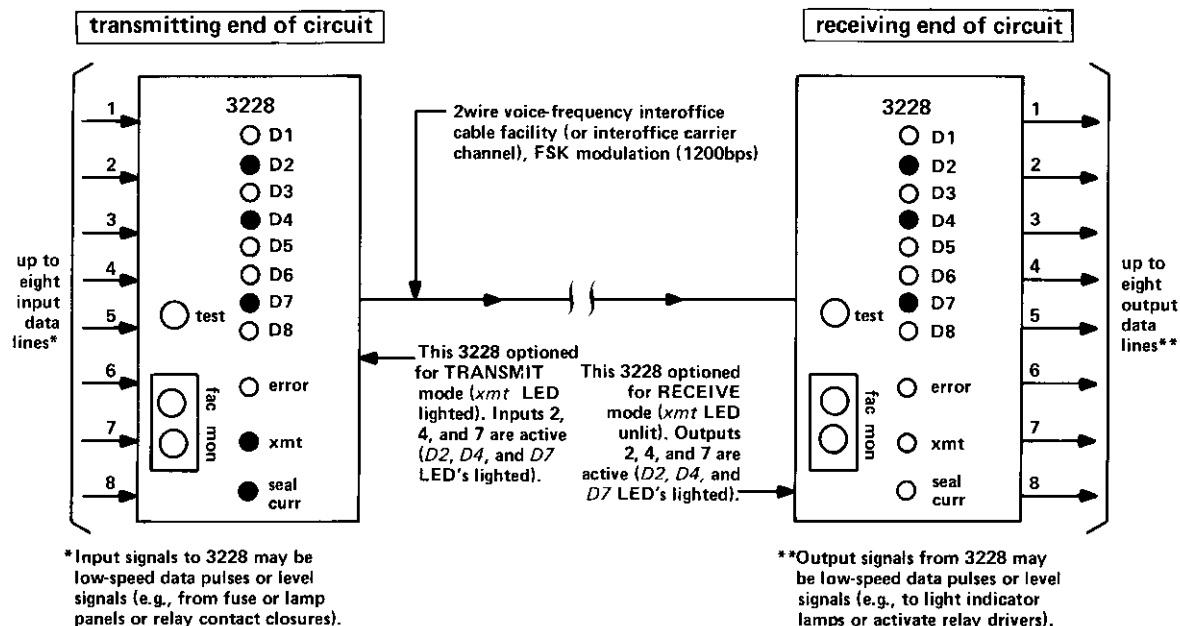


figure 2. Transmit and receive modes of 3228

### use with 243 low-speed data signaling system

2.02 One major application of the 3228 module involves its use with the Tellabs 243 Low-Speed Data Signaling System. Designed for unidirectional transmission of low-speed (up to 15bps) loop-status signals of the type generated by McCulloh-formatted customer-premises alarm systems, the 243 System comprises a transmitting portion and a receiving portion that are physically located at opposite ends of a circuit, often in different CO's. The transmitting portion consists of one 4311 Data Conversion Module and one to five associated 4312 Loop Interface Modules. The receiving portion consists of a single 4313 Alarm Station Interface Module. Signal transmission between the two portions takes place over two separate, independent inter-office facilities, one for each of the two types of signals (designated *N1* and *G1*) generated by the 4311 module. When these facilities are carrier channels, a pair of 3228's (optioned for transmit operation) can serve as the required interfaces between the two transmitting-end outputs of the 243 System and the carrier channels; a second pair of 3228's (optioned for receive operation) can serve as the required interface between the carrier channels and the two receiving-end inputs of the 243 System. In such applications, the two pairs of 3228's can serve up to eight separate 243 Systems, as shown in figure 3.

2.03 If space permits, the two 3228's at the transmitting end of the circuit can be housed in the same Tellabs 24X Mounting Assembly that houses the 4311 and 4312 modules of one or more 243 Systems. Otherwise, the transmitting-end 3228's can be housed in a separate Tellabs Type 10 Mounting Shelf. Similarly, if space permits, the two 3228's at the receiving end of the circuit can be housed in the same Type 10 Shelf (or, less frequently, in the same 24X Assembly) that houses the 4313 modules of one or more 243 Systems. Otherwise, the receiving-end 3228's can be housed in a separate Type 10 Shelf. For complete information on the 243 Low-Speed Data Signaling System, please refer to its two Tellabs Practices, section 82243/824311/814312 and section 82243/814313.

### telemetry applications

2.04 A second major application of the 3228 module is in telemetry arrangements involving the Tellabs 6231 20mA-Loop-to-Level Converter and 6232 Level-to-20mA-Loop Converter modules. At the transmitting end of such an arrangement (see figure 4), a 6231 module interfaces up to eight 2wire metallic loops on its input side. These loops carry 20mA loop-status signals that are generated, in many cases, in response to relay operation initiated by blown fuses, disabled carrier channels, or changes in the operational status of other equipment. Upon receipt of these loop-status signals, the 6231 converts them to single-ended voltage levels at its eight outputs, which are, in turn, connected to the eight inputs of an associated 3228 module optioned for transmit. The 3228 processes the levels received from the 6231 for transmission to

the receiving end of the circuit. At the receiving end, a 3228 module optioned for receive converts the incoming signals into single-ended voltage levels at its eight outputs. A 6232 module, whose eight inputs are connected to the 3228's eight outputs, then converts the levels received from the 3228 into 20mA loop-status signals for transmission toward their destination.

### time-of-day OUTWATS billing arrangements

2.05 Another application of the 3228 module is in FCC-required time-of-day billing arrangements for OUTWATS customers. This type of arrangement involves use of the 3228 in conjunction with the Tellabs 6991 OUTWATS Adapter module, as shown in figure 5. (In brief, the microprocessor-based 6991 allows OUTWATS service to be provided to a customer directly from a Class 3 or Class 4 toll center without the need for routing the customer's line through an intermediate Class 5 end office. Thus, the OUTWATS customer is connected directly to the toll network; the customer's local end office is bypassed, and its toll-originating traffic is reduced.) To implement time-of-day OUTWATS billing, a 6991's usage-metering (seizure and answer) leads are connected to two inputs of a transmit-mode 3228 module. (With its eight inputs, one 3228 can serve up to four 6991's, as shown.) The 3228 receives the usage-metering data from the 6991 modules and transmits it over an inter-office facility to a receive-mode 3228 at a distant CO. Centralized automatic message accounting (CAMA) equipment at the distant CO receives the usage-metering data from the receive-mode 3228 and analyzes the data for billing purposes.

### ground-closure alarm applications

2.06 In applications involving customer-location alarm devices that provide open outputs when idle and ground outputs (via ground-closure relay contacts) when activated, the 3228 module can interface the alarm devices directly, as shown in figure 6. Please note that in such ground-closure applications, the 3228 optioned for transmit (to whose inputs the alarm devices are connected) must also be switch-optioned for internal battery reference to its input data channels. By adding a Tellabs 9091 Diode Matrix module and an associated Tellabs 9001 Relay Module as shown, the outputs of the 3228 module optioned for receive can be logic-ORed to provide audible and visible alarm indications, as well as cutoff for the audible alarm, at a remote alarm-reporting site.

### other applications

2.07 In addition to those just described, other applications of the 3228 module are possible. Should you have any questions regarding use of the 3228 in a particular application, please call Tellabs' Application Engineering Group at your Tellabs regional office or at our U.S. or Canadian headquarters. Telephone numbers are listed in paragraph 7.02.

transmitting end of circuit

receiving end of circuit

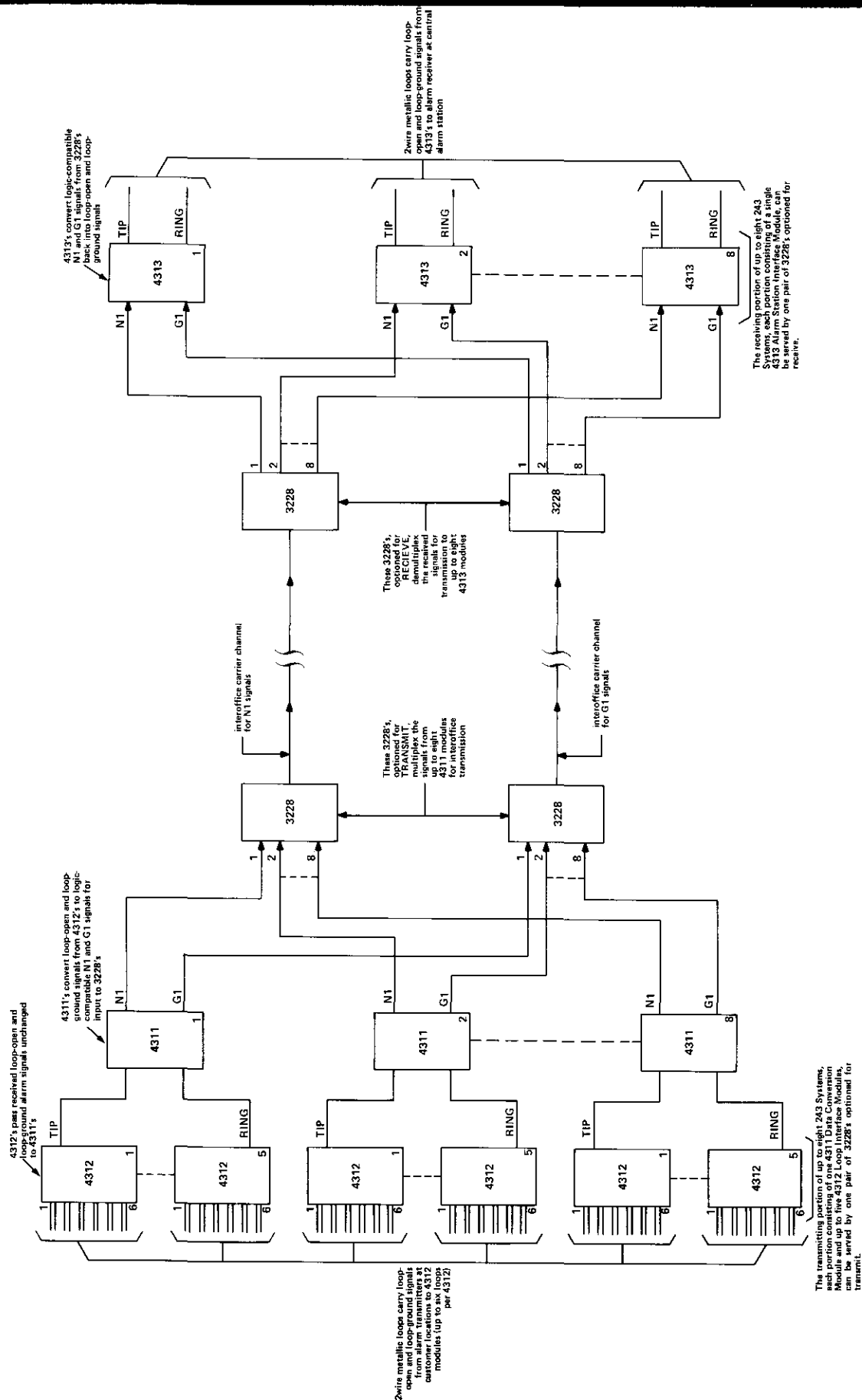


figure 3. Use of 3228 with 243 Low-Speed Data Signaling System

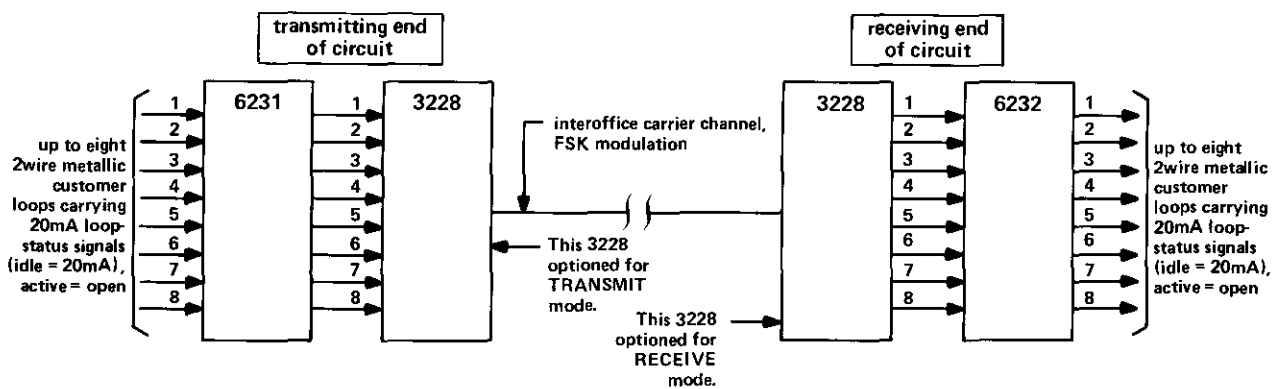


figure 4. Use of 3228 in telemetry application

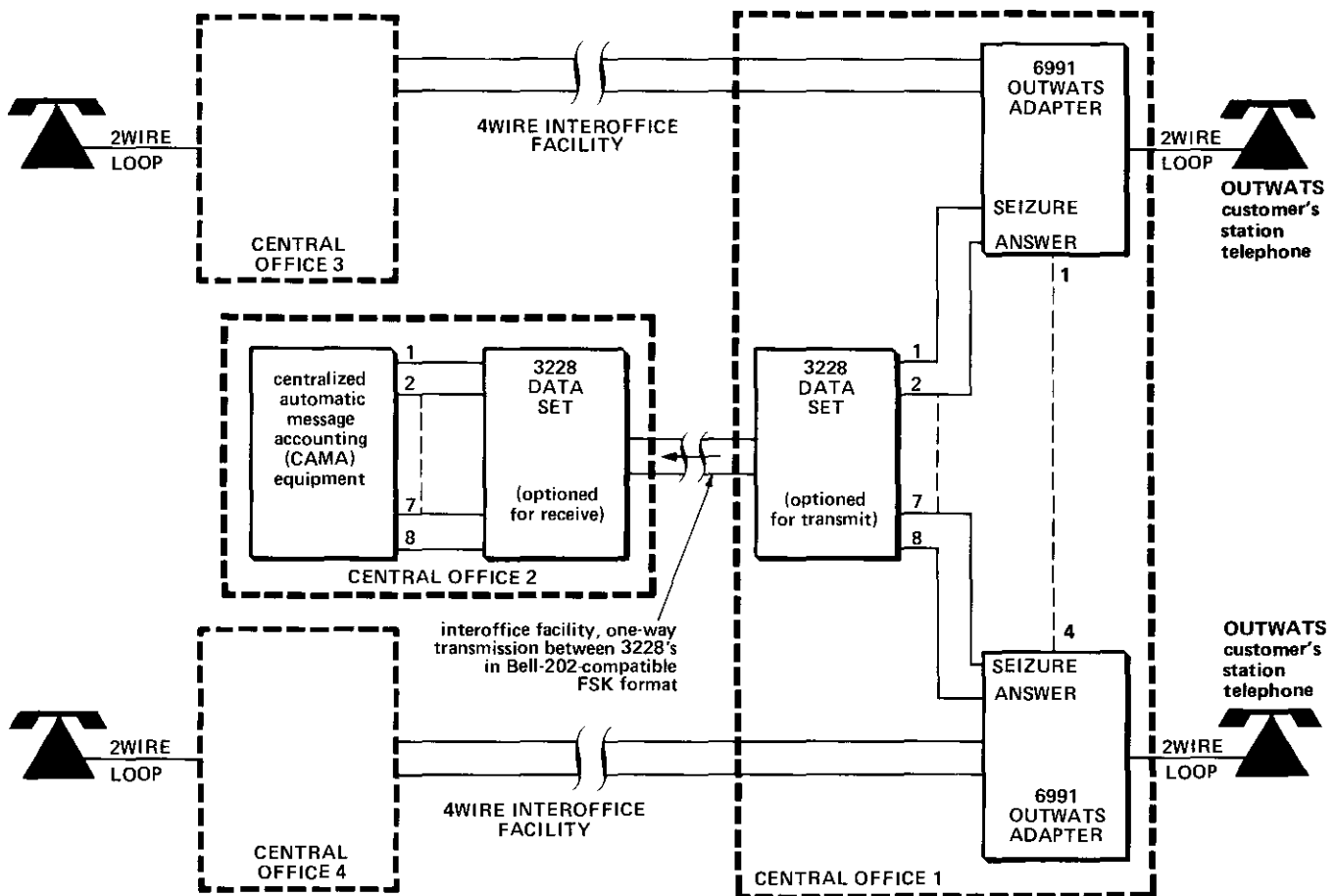


figure 5. Use of 3228 in time-of-day OUTWATS billing applications

**data-channel levels and scan rate, transmit mode**

**2.08** When optioned for the transmit mode, the 3228 module scans the single-ended voltage levels (referenced to ground) of its eight data input channels and multiplexes received level information for transmission as an asynchronous serial data word. Normally, an input level between  $-48\text{Vdc}$  and approximately  $-22\text{Vdc}$  is recognized by the 3228 as a logic 0 or an inactive state, while an input level between  $-18\text{Vdc}$  and  $0\text{Vdc}$  is recognized as a logic 1 or an active state. If necessary for a particular application, however, the 3228 can be switch-optioned for inverted input-channel logic states, in which case an input level between  $-48\text{Vdc}$  and approximately  $-22\text{Vdc}$  is recognized as a logic 1 (active) and an input level between  $-18\text{Vdc}$  and  $0\text{Vdc}$  is

recognized as a logic 0 (inactive). Also, an open data channel (no external battery reference provided) is normally detected as a  $0\text{Vdc}$  input level. However, for applications where ground-closure relay contacts provide inputs to the 3228 directly, a switch option on the module provides the necessary internal battery reference to the input data channels.

**2.09** Another switch option on the 3228 permits scanning of its eight input data channels (when optioned for transmit) at scanning rates that accommodate a maximum data transfer rate of either 15 or 30 baud. When optioned for 15 baud (maximum), the 3228 accepts level information at rates between 0pps (dc) and 15pps. When optioned for 30 baud (maximum), the 3228 accepts level information at rates between 0pps (dc) and 30pps.

# alarm-reporting site

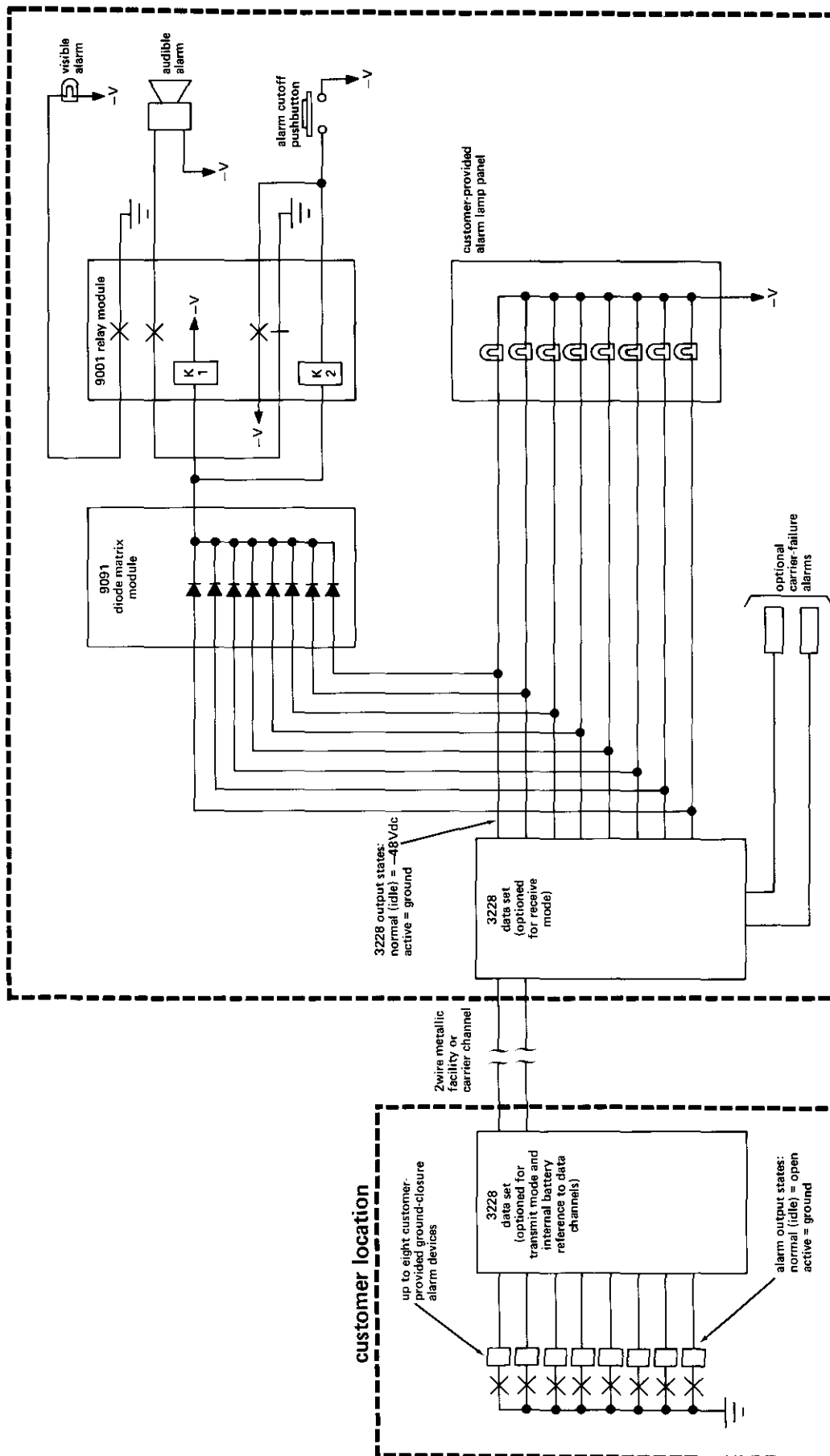


figure 6. Use of 3228 with ground-closure alarm devices

**data-channel levels, receive mode**

2.10 When the 3228 is optioned for the receive mode, the 3228 module demultiplexes the incoming asynchronous serial data and uses the resulting demultiplexed signals to control the levels of its eight single-ended (referenced to ground) data output channels. Normally, an output level of  $-48\text{Vdc}$  or  $-24\text{Vdc}$  (depending upon input voltage) defines a logic 0 or an inactive state, while an output level of  $0\text{Vdc}$  (ground) defines a logic 1 or an active state. If necessary for a particular application, however, the 3228 can be switch-optioned for inverted output-channel logic states, in which case an output level of  $-48\text{Vdc}$  or  $-24\text{Vdc}$  (depending upon input voltage) defines a logic 1 or an active state and an output level of  $0\text{Vdc}$  (ground) defines a logic 0 or an inactive state.

**data-channel logic-state LED indications**

2.11 Regardless of whether the 3228 is optioned for transmit or receive, its eight front-panel LED's labeled *D1* through *D8* indicate the logic state of each data channel. A lighted LED indicates a logic 1 (active), while an unlighted LED indicates a logic 0 (inactive).

**data transmission format, transmit mode**

2.12 When the 3228 is optioned for the transmit mode, single-ended voltage levels at the module's eight input data channels are transformed into binary equivalent values as described in paragraph 2.08. These binary values are combined with a start bit and a stop bit to form a 10-bit asynchronous serial data word (figure 7), the format of which is widely used in data communications.

**Note:** *This serial data word is transmitted over a 2wire transmission facility or a carrier channel by means of Bell-System-202-compatible FSK data transmission techniques. An FSK frequency of 1200Hz signifies a "mark" condition, while a 2200Hz signal represents a "space" condition. The serial-data transmission rate is 1200 bits per second, which provides compatibility with Bell System 202 data modems.*

**data transmission format, receive mode**

2.13 When optioned for the receive mode, the 3228 module demodulates incoming FSK voice-frequency signals. The start and stop bits are removed from the received asynchronous serial data

words, and the eight data bits of each word are stored and used to control the levels of the output data channels as described in paragraph 2.10.

**data transmission levels, transmit and receive modes**

2.14 When the 3228 is optioned for transmit, the output level of outgoing FSK voice-frequency signals at its 2wire transmit port can be adjusted from  $-15$  to  $0\text{dBm}$  in  $1\text{dB}$  increments via four-position DIP switch *S5* on the module's printed circuit board. When optioned for receive, the 3228 will receive incoming FSK voice-frequency signals at its 2wire receive port at levels ranging from  $+2$  to  $-30\text{dBm}$ .

**data-transfer error and power-failure detection**

2.15 The 3228 module continuously monitors the operational status of its data transmit section (transmit mode) or its data receive section (receive mode). Failure to transmit a serial data word for more than 1 second (transmit mode) or failure to receive a valid serial data word (due to loss of carrier) for more than 1 second (receive mode) is detected by the 3228 as an error condition. (Detection of such data-transfer errors takes place at the module's 2wire facility port.) The module's front-panel *error* LED lights, a normally energized internal alarm relay releases (providing contact closure for external alarm indications), and all data channels are forced to their active levels. Upon resumption of correct operation of the 3228's data transmit or data receive section, the *error* LED extinguishes, the alarm relay operates (opening its contacts), and all data channels return to their normal operating levels (as described in paragraphs 2.08 and 2.10).

**Note:** *In either the transmit or receive mode, the 3228 can be switch-optioned so that its data channels will not be forced to the active state during detected error conditions. Instead, each data channel will remain at the last valid state which existed for that channel prior to detection of the error condition.*

2.16 When power to the 3228 module fails, its internal alarm relay releases, providing contact closure for external alarm indications.

**use of test pushbutton**

2.17 The 3228's front-panel *test* pushbutton allows all data channels to be forced to their active

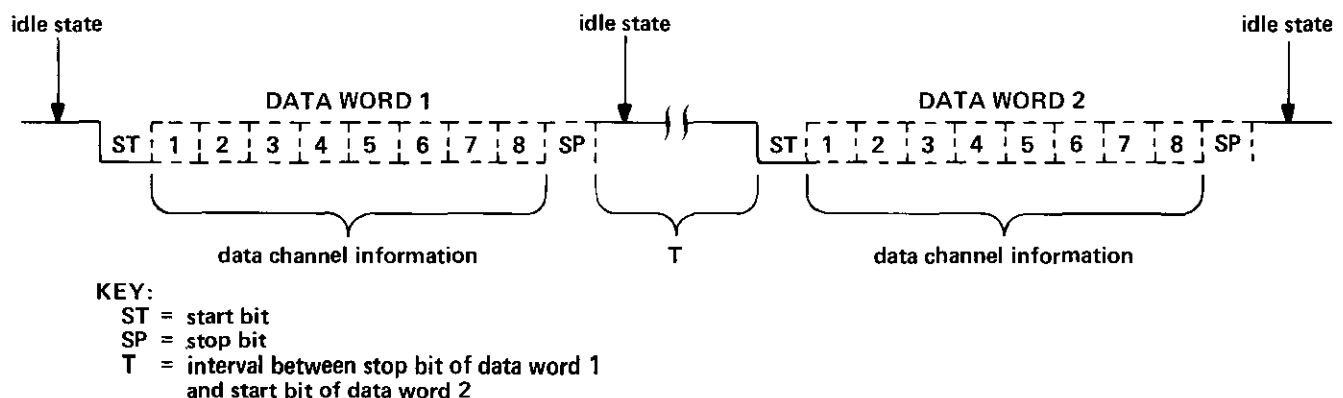


figure 7. Asynchronous serial data word format of 3228

levels for testing purposes. In the transmit mode, depressing the *test* pushbutton forces all eight input data channels active, and subsequent serial data transmission reflects this condition. In the receive mode, depressing the *test* pushbutton forces all eight output data channels active.

### 2wire facility interface and sealing current

2.18 An impedance-matching transformer at the 3228 module's 2wire facility port can be switch-optional for balanced 150-, 600-, or 1200-ohm terminating impedance. This allows the module to interface either loaded cable (1200 ohms) or non-loaded cable or a carrier channel (600 ohms). The 150-ohm option presents a deliberate impedance mismatch that provides a small degree of amplitude equalization for nonloaded cable facilities.

2.19 An option switch on the 3228 allows 20mA of sealing current from a source integral to the module to be applied to a metallic cable pair interfacing the 2wire facility port. When the sealing-current option is selected, current flows out on the 2wire facility ring lead (pin 13) and returns on the 2wire facility tip lead (pin 7). A ZAP feature integral to the 3228's sealing-current supply provides a momentarily higher amount of current to eliminate existing oxidation or corrosion on the facility when the sealing-current option is initially activated. Also, the front-panel *seal curr* LED lights while sealing current is flowing.

## 3. installation inspection

3.01 The 3228 Data Set Transmit/Receive 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 3228 module mounts in one position of the Tellabs Type 10 Mounting Shelf, which is available in configurations for relay-rack and apparatus-case installation. If desired, the 3228 can also be mounted in one position of the rack-mounted Tellabs 24X Mounting Assembly or in one position of a wall-mounted Tellabs 1911, 1912, 1913, or 1914 Apparatus Case. The module plugs physically and electrically into a 56-pin connector at the rear of its Shelf, Assembly, or Apparatus Case position.

### installer connections

3.03 If the 3228 is to be installed in a 24X Mounting Assembly, no external connections to the module need be made because all intermodule connections in the Assembly are prewired and all external connections to the Assembly (except battery and ground) are made via connectorized cables. For details on the 24X Issue 2 Mounting Assembly, please refer to the 24X Mounting Assembly Practice (section 8224X). For details on the 24X Issue 1 (also known as the 242) Mounting Assembly, please refer to the Issue 1 242 Distributive Data Bridge System Practice (section 81242).

3.04 If, however, the 3228 module is to be installed in a conventional Type 10 Shelf or in any of the aforementioned unwired Apparatus Cases, external connections to the module must be made. Before doing so, ensure that power is **off** and modules are **removed**. The 3228 should be inserted into its position only **after** it is properly optioned and **after** wiring is completed. For details on the Type 10 Shelves and on the 1911, 1912, 1913, and 1914 Apparatus Cases, please refer to their respective Tellabs Practices (sections 8210XX, 811911/811912, 821913, and 821914).

3.05 Table 1 lists external connections to the 3228. If the module is to be installed in a conventional Type 10 Shelf or in an unwired Apparatus Case, all connections are made via wire wrapping at the rear of the module's Shelf or Apparatus Case position. Pin numbers are found on the body of the connector.

connect:	to pin:
2WIRE FACILITY TIP . . . . .	7
2WIRE FACILITY RING . . . . .	13
D1 (data channel 1) . . . . .	14
D2 (data channel 2) . . . . .	8
D3 (data channel 3) . . . . .	48
D4 (data channel 4) . . . . .	44
D5 (data channel 5) . . . . .	43
D6 (data channel 6) . . . . .	9
D7 (data channel 7) . . . . .	47
D8 (data channel 8) . . . . .	41
E1 (alarm relay contact E1) . . . . .	45
E2 (alarm relay contact E2) . . . . .	49
-BATT (-24 to -56Vdc, filtered, ground referenced) . . . . .	35
GND (ground) . . . . .	17

table 1. External connections to 3228

### option selection

3.06 Three option switches must be set before the 3228 is placed into service. Two of these switches are slide switches, and one is a four-position DIP switch. (A second four-position DIP switch, S5, is used only in the transmit mode for prescription adjustment of the module's output level at the 2wire facility port. The setting of this switch is covered separately in the subsection of this Practice entitled **output level adjustment (transmit mode)**, which follows **option selection**.) Locations of all switches on the module's printed circuit board are shown in figure 8.

Table 2 provides a brief explanation of the function and settings of each option switch plus output-level-control switch S5. Also included in table 2 is a convenient option checklist. This checklist can be filled out (by checking the appropriate box for each switch) either prior to installation to allow prescription optioning of the

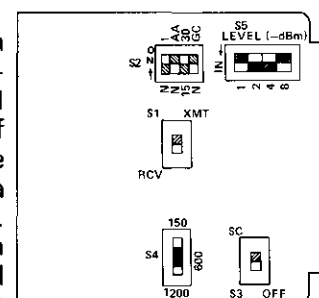


figure 8. 3228 option switch locations



module or as the module is being optioned to provide a record for future reference. Detailed instructions for optioning the 3228 and for setting its transmit-mode output level are provided in paragraphs 3.07 through 3.14.

option	switch	selections	settings	check-list
transmit or receive operating mode	S1	transmit mode receive mode	XMT RCV	
2wire facility port impedance	S4	1200 ohms 600 ohms 150 ohms	1200 600 150	
application of internally generated sealing current to 2wire facility	S3	20mA sealing current applied no sealing current applied	SC OFF	
data-channel scanning rate (transmit mode)	S2-3	0 to 15pps 0 to 30pps	15 30	
definition of active and inactive logic states by normal or inverted data channel levels	S2-1	-48Vdc = inactive, 0Vdc (gnd) = active -48Vdc = active, 0Vdc (gnd) = inactive	N I	
ground-closure or normal applications (transmit mode)	S2-4	ground-closure applications normal applications	GC N	
levels of data channels during error conditions	S2-2	all data channels forced active each data channel remains at last valid state prior to error detection	AA N	
2wire facility port output level (transmit mode)	four-position DIP switch S5 [labeled LEVEL (-dBm)] *	-1dBm -2dBm -4dBm -8dBm	1 to IN 2 to IN 4 to IN 8 to IN	

\*Although switch S5 is a four-position DIP switch, its positions are not numbered 1 through 4. Instead, they are numbered according to the level (in -dBm) that each one selects when set to *IN*. Furthermore, these switch positions are cumulative; the output level selected is the sum of those S5 positions set to *IN*. For example, for a -15dBm output level, all four positions are set to *IN*; for a 0dBm output level, none of the positions is set to *IN*; and for a -11dBm output level, positions 8, 2, and 1 are set to *IN*.

table 2. Summary and checklist, 3228 switch options

3.07 The transmit or receive operating mode of the 3228 is selected via switch S1. For operation of the 3228 as a transmit data set, set S1 to the *XMT* position. For operation of the 3228 as a receive data set, set S1 to the *RCV* position.

3.08 The terminating impedance of the 2wire facility port is selected via switch S4. For 1200-ohm terminating impedance (as is typically required for interface with loaded cable), set S4 to the *1200* position. For 600-ohm terminating impedance (as is typically required for interface with carrier channels or short sections of nonloaded cable, i.e., sections with less than 4dB of loss at 1kHz), set S4 to the *600* position. For 150-ohm terminating impedance (as is typically required for interface with long sections of nonloaded cable, i.e., sections with 4dB or greater loss at 1kHz), set S4 to the *150* position. The 150-ohm option provides a small amount of amplitude equalization for nonloaded cable facilities.

3.09 Application of internally generated 20mA sealing current at the 3228's 2wire facility port is controlled via switch S3. To provide sealing cur-

rent to a metallic facility, set S3 to the *SC* position. If sealing current is not desired, set S3 to *OFF*.

**Caution:** Only one of the two 3228's on a data link should be optioned to supply sealing current.

3.10 The data-channel scanning rate for a transmit-mode 3228 is selected via position 3 of DIP switch S2. For a data-channel scanning rate that will accommodate data-transfer rates from Opps (dc) to 15pps, set S2-3 to the *15* position. For a data-channel scanning rate that will accommodate data-transfer rates from Opps (dc) to 30pps, set S2-3 to the *30* position.

3.11 Whether normal or inverted data-channel levels define the 3228's active and inactive logic states is selected via position 1 of DIP switch S2. For a data-channel level of -48Vdc to define the inactive (logic 0) state and a data-channel level of 0Vdc (ground) to define the active (logic 1) state, set S2-1 to the *N* (normal) position. For a data-channel level of -48Vdc to define the active (logic 1) state and a data-channel level of 0Vdc (ground) to define the inactive (logic 0) state, set S2-1 to the *I* (inverted) position.

3.12 When optioned for the transmit mode, the 3228 is conditioned for either ground-closure or normal applications via position 4 of DIP switch S2. In ground-closure applications only, set S2-4 to the *GC* position to provide the necessary internal battery reference to the module's input data channels. In all other applications, set S2-4 to the *N* (normal) position, in which case it is assumed that external battery reference is being provided to the 3228's input data channels.

3.13 The levels of the 3228's data channels during error conditions can be controlled via position 2 of DIP switch S2. If it is desired that all data channels be forced to the active state (as determined by the setting of switch S2-1), during error conditions, set S2-2 to the *AA* (all active) position. If it is desired that each data channel remain at the last valid state (active or inactive) which existed for that channel prior to detection of the error condition, set S2-2 to the *N* (normal) position.

#### output level adjustment (transmit mode)

3.14 When the 3228 is optioned for the transmit operating mode, its FSK output signal can be prescription-set (in 1dB increments) for any level between -15 and 0dBm via four-position option switch S5. To adjust the module's output level, proceed as follows:

- Ensure that option switch S1 on the 3228 is set to the *XMT* position.
- Select the required level by setting to *IN* that combination of switch S5 positions which adds up to the required level. The specific level in -dBm selected by each S5 switch position is indicated on the switch: 1, 2, 4, and 8 for -1, -2, -4, and -8dBm, respectively. These switch positions are cumulative; the output level

selected is the sum of the switch positions set to */N*. (Thus, setting all four positions to */N* gives -15dBm, setting no positions to */N* gives 0dBm, and setting an appropriate combination of positions to */N* gives any desired level in between.)

#### 4. circuit description

4.01 This circuit description is intended to familiarize you with the 3228 Data Set Transmit/Receive module for engineering and application purposes only. Attempts to troubleshoot the 3228 internally are not recommended and may void its warranty. Troubleshooting procedures should be limited to those prescribed in section 7 of this Practice. Please refer to the block diagram, section 5 of this Practice, as an aid in following the circuit description.

##### operating modes

4.02 The 3228 functions either as a transmit data set at the originating end, or as a receive data set at the terminating end, of a 2wire voice-frequency transmission facility. The transmit or receive operating mode is established via option switch *S1*, which establishes the manner in which the common *data channel interface*, the *communication section*, and the transformer-coupled *2wire facility interface* will be used.

##### data channel interface

4.03 The *data channel interface* section provides interconnection between the eight data channels (*D1* through *D8*) and the *asynchronous serial communication integrated circuit* (IC) as follows:

A. In the **transmit mode**, the single-ended voltage levels (referenced to ground) on the eight input data channels are converted into binary values that are passed on to the *data in* port of the *asynchronous serial communication IC*.

B. In the **receive mode**, the binary values at the *data out* port of the *asynchronous serial communication IC* are converted into single-ended voltage levels (referenced to ground) on the eight output data channels.

4.04 In either the transmit or the receive mode, option switch *S2-1* determines whether normal or inverted data-channel levels define the 3228's active and inactive logic states, as described in paragraphs 2.08, 2.10, and 3.11. Also, in either operating mode, all of the 3228's eight data channels can be forced to their active state (as defined by the setting of switch *S2-1*) by means of the module's front-panel *test* pushbutton.

##### communication section

4.05 The *communication section* provides interconnection between the *data channel interface* and the *2wire facility* port as follows:

A. In the **transmit mode**, the eight data bits at the *data in* port of the *asynchronous serial communication IC* are combined with a start and a stop bit to form a 10-bit asynchronous serial data word at the IC's *serial out* port. The rate at which the eight data bits are scanned

(i.e., to accommodate data transfer rates up to either 15 baud or 30 baud) is selected via option switch *S2-3*. The asynchronous serial data is transformed into voice-frequency signals, through use of FSK modulation techniques, by the *FSK modulation IC*. The output level of the voice-frequency data signals being transmitted out of the 3228's *2wire facility* port is adjusted (in 1dB increments) for any value between -15 and 0dBm via four-position DIP switch *S5*.

B. In the **receive mode**, incoming FSK voice-frequency data signals are demodulated by the *FSK demodulation IC* and passed on to the *serial in* port of the *asynchronous serial communication IC*. The value of the data bits at the *data out* port of the *asynchronous serial communication IC* is updated for each received serial data word.

##### 2wire facility interface

4.06 In the 3228's *2wire facility interface* section, an impedance-matching transformer provides balanced coupling between either the *FSK modulation IC* (transmit mode) or the *FSK demodulation IC* (receive mode) and the *2wire facility* port. Option switch *S4* selects either 1200-, 600-, or 150-ohm balanced terminating impedance at the *2wire facility* port.

##### control section

4.07 The 3228 continuously monitors the operational status of its data-transfer circuitry via its *control section*. Failure either to transmit a serial data word (transmit mode) or to receive a valid serial data word (receive mode) for more than 1 second is detected by the *control section* as an error condition, and the following responses are initiated:

A. The front-panel *error* LED lights.

B. The *alarm relay* (*K1*) de-energizes, causing contact closure between pins 45 and 49.

C. If option switch *S2-2* is set to *AA* (all active), all eight data channels are forced to the active state. If, however, switch *S2-2* is set to *N* (normal), each data channel remains at the last valid state (active or inactive) that existed for that channel prior to detection of the error condition.

Whenever correct data-transfer operation resumes, the error responses listed above are removed.

##### data-channel LED's

4.08 In either the transmit or the receive mode, the logic state of each of the 3228's eight data channels (*D1* through *D8*) is indicated by a corresponding LED on the module's front panel. Lighted LED's indicate active data channels; unlighted LED's indicate inactive data channels.

##### test jacks

4.09 Two front-panel bantam-type test jacks on the 3228's 2wire side provide access to the 2wire facility for alignment and maintenance purposes. One of these jacks, labeled *fac*, is an opening jack

facing the facility; the other, labeled *mon*, is a monitoring jack that bridges the facility.

#### sealing-current source

4.10 An integral *sealing-current source* in the 3228 provides approximately 20mA of current at the module's *2wire facility* port (with a higher current supplied momentarily when the *sealing-current source* is initially activated). Current flows out on the ring lead (pin 13) and returns on the tip lead (pin 7). A front-panel *seal curr* LED lights while current is flowing. The *sealing-current source* can be switch-optional out of the circuit via switch S3 if sealing current is not desired.

#### power supply

4.11 The *power supply* in the 3228 is a series voltage regulator that uses a zener diode as a reference source. A series diode in the battery input lead (*-BATT*) protects the circuit against reversed input power connections, and a high-voltage zener diode between input battery and ground limits high-level supply transients to a safe level.

### 6. specifications

**Note:** *Except where noted, specifications apply to both the transmit and receive operating modes of the 3228.*

#### data channels

##### type

eight input (transmit mode) or output (receive mode) data channels, single-ended (referenced to ground)

*normal input levels, transmit mode, with -48Vdc input battery*

logic 0 or inactive state: -22 to -56Vdc

logic 1 or active state: -18 to 0Vdc (ground)

**Note:** *These input level definitions can be inverted via switch option.*

*input levels, transmit mode, with ground-closure switch option selected*

logic 0 or inactive state: open relay contact

logic 1 or active state: ground-closure relay contact

*input data rate, transmit mode*

0 pulses per second (dc) to a maximum of either 15pps or 30pps, as selected via switch option. Minimum pulse duration must be 34ms at 15pps and 17ms at 30pps.

*normal output levels, receive mode, with -48Vdc input battery*

logic 0 or inactive state: input battery (-24 or -48Vdc) through 6.8 kilohms

logic 1 or active state: 0Vdc (ground) through 20 ohms

**Note:** *These output level definitions can be inverted via switch option.*

#### 2wire facility port

##### data format

10-bit asynchronous serial data word

##### data rate

1200 bits per second

*output (transmit mode) or input (receive mode)*

FSK modulation (transmit) or demodulation (receive), mark = 1200Hz  $\pm 3\%$ , space = 2200 Hz  $\pm 3\%$

*output level, transmit mode*

-15 to 0dBm, switch-selectable in 1dB increments

*input level, receive mode*

+2 to -30dBm

*terminating impedance*

1200, 600, or 150 ohms, balanced, switch-selectable

#### common specifications

*longitudinal balance*

greater than 60dB

*echo return loss*

greater than 28dB

*error detection timing*

loss of data transfer at 2wire facility port for more than 1 second activates module's error indications

*integral sealing-current source*

20mA (nominal) sealing current with ZAP feature (see paragraph 2.19) at 2wire facility port, excludable via switch option

*input voltage*

-22 to -56Vdc, filtered, ground referenced

*input current*

transmit mode: 86mA at idle, 95mA maximum (plus an additional 20mA with sealing-current option active)  
receive mode: 70mA at idle, 125mA maximum (plus an additional 20mA with sealing-current option active)

*operating environment*

32° to 135° F (0° to 60° 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*

12 ounces (340 grams)

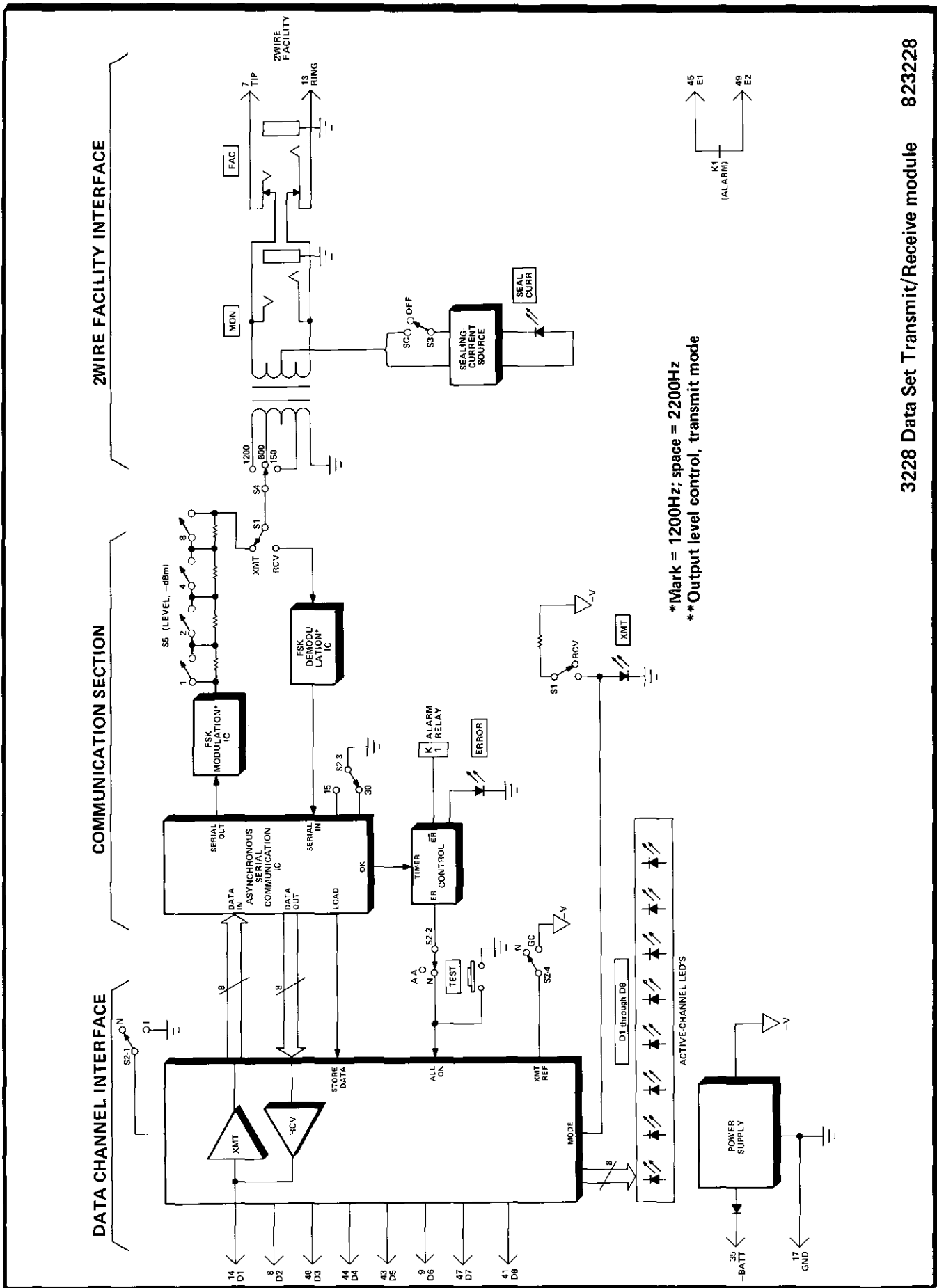
*mounting*

relay rack or apparatus case via one position of Tellabs Type 10 Mounting Shelf; also mounts in one position of Tellabs 24X Mounting Assembly or in one position of Tellabs 1911, 1912, 1913, or 1914 Apparatus Case.

### 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 3228 Data Set Transmit/Receive module. The Checklist is intended as an aid in the localization of trouble to a specific module. If a module is suspected of being defective, a new one should be substituted and the test conducted again. If the substitute module operates correctly, the original module should be considered defective and returned to Tellabs for repair or replacement. We strongly recommend that no internal (component-level) testing or repairs be attempted on the module. Unauthorized testing or repairs may void the module's warranty.

**Note:** *Warranty service does not include removal of permanent customer markings on the front panels of Tellabs modules, although an attempt will be made to do so. If a module must be marked defective, we recommend that it be done on a piece of tape or on a removable stick-on label.*



7.02 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

7.03 If a 3228 is diagnosed as defective, the situation may be remedied by either *replacement* or *repair and return*. Because it is more expedient, the *replacement* procedure should be followed whenever time is a critical factor (e.g., service outages, etc.).

#### replacement

7.04 To obtain a replacement 3228 module, 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 8X3228 part number that indicates the issue of the

module in question. Upon notification, we shall ship a replacement module to you. If the module in question is in warranty, the replacement will be shipped at no charge. Pack the defective 3228 in the replacement module's carton, sign the packing slip included with the replacement, and enclose it with the defective module (this is your return authorization). Affix the preaddressed label provided with the replacement module to the carton being returned, and ship the module prepaid to Tellabs.

#### repair and return

7.05 Return the defective 3228 module, 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 module's malfunction. Follow your company's standard procedure with regard to administrative paperwork. Tellabs will repair the module and ship it back to you. If the module is in warranty, no invoice will be issued.

### testing guide checklist

*Note: In the following procedures, end-to-end tests must be performed.*

test	test procedure	normal result	if normal conditions are not met, verify:
data-channel levels, transmit or receive mode	Depress front-panel <i>test</i> pushbutton on 3228 optioned for either transmit or receive.	In either transmit or receive mode, all eight data-channel LED's ( <i>D1</i> through <i>D8</i> ) light for as long as <i>test</i> pushbutton is held depressed <input type="checkbox"/> .	Power <input type="checkbox"/> . Wiring <input type="checkbox"/> . Logic-state level-definition optioning (switch <i>S2-1</i> ) <input type="checkbox"/> . Replace module and retest <input type="checkbox"/> .
data transmission, transmit mode	At <b>receiving</b> end of circuit, connect 2wire facility from transmit 3228 being tested to input of known-good (and operating) receive 3228.	Receive 3228's LED's reflect data-channel levels of transmit 3228 being tested <input type="checkbox"/> .	Power <input type="checkbox"/> . Wiring <input type="checkbox"/> . Operating mode (switch <i>S1</i> ) of transmit 3228 properly set <input type="checkbox"/> . Terminating impedance (switch <i>S4</i> ) of both 3228's properly set <input type="checkbox"/> . Output level of transmit 3228 properly set <input type="checkbox"/> . Replace transmit 3228 and retest <input type="checkbox"/> .
data reception, receive mode	At <b>transmitting</b> end of circuit, connect 2wire facility from receive 3228 being tested to output of known-good (and operating) transmit 3228.	LED's of receive 3228 being tested reflect data-channel levels of transmit 3228 <input type="checkbox"/> .	Power <input type="checkbox"/> . Wiring <input type="checkbox"/> . Operating mode (switch <i>S1</i> ) of receive 3228 properly set <input type="checkbox"/> . Terminating impedance (switch <i>S4</i> ) of both 3228's properly set <input type="checkbox"/> . Incoming FSK signals within acceptable level range <input type="checkbox"/> . Replace receive 3228 and retest <input type="checkbox"/> .
sealing current	With module optioned for sealing current ( <i>S3</i> set to <i>SC</i> ), connect VOM (arranged to measure up to 50mA) to 2wire facility tip (pin 7) and ring (pin 13) leads. (Do not use <i>fac</i> jack for this measurement.)	VOM indicates approximately 20mA <input type="checkbox"/> .	Power <input type="checkbox"/> . Wiring <input type="checkbox"/> . Switch <i>S3</i> properly set <input type="checkbox"/> . Replace 3228 and retest <input type="checkbox"/> .



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*4951 Indiana Avenue, Lisle, Illinois 60532  
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