tellabs
technical manual
76-816991
rev A

practice section 816991

6991 2Wire-to-4Wire E&M OUTWATS Adapter

contents

1. general description

1.01 The Tellabs 6991 2Wire-to-4Wire E&M OUTWATS Adapter (figure 1) is an auxiliary trunk control module that directly interfaces 2wire station equipment with a Class 3 or Class 4 toll switching center. The 6991 performs all necessary supervisory and signaling functions normally performed by a Class 5 end office. The module also provides usage-metering leads compatible with various types of metering systems. The 6991 therefore eliminates the need for OUTWATS calls to be routed through a Class 5 end office.

1.02 In the event that this Practice section is reissued, the reason for reissue will be stated in this paragraph.

1.03 The heart of the 6991 is a microcomputer that provides dial tone, automatically accepts dialed digits from either dual-tone multifrequency (DTMF) or rotary-dial telephones (no optioning required), stores the dialed digits, generates multifrequency (MF) tones or pulses the M lead, and in general controls all supervisory and signaling functions. In addition, different digit-processing formats are possible (on special order) by changing the EPROM (erasable programmable read only memory).

1.04 An integral toll-grade hybrid terminating set in the 6991 provides 4wire-to-2wire conversion. Balanced, switch-selectable 600 or 900-ohm (in series with 2.15μF) terminating impedance is provided at the 2wire port, while fixed, balanced 600-ohm terminating impedance is provided at the 4wire transmit and receive ports. Network build-out capacitors associated with the term set's internal compromise balance network provide from 0 to 0.155μF of NBO capacitance in 0.005μF increments. The compromise network may be excluded from the circuit via switch option when use of a precision balance network (PBN) is preferred. This PBN may be provided either as an external PBN module (e.g., a Tellabs 423X) or, more conveniently, as a Tellabs 993X PBN subassembly, which plugs into a receptacle on the 6991's printed circuit board. Refer to the 423X and 993X Tellabs Practices for details on these modules and subassemblies.

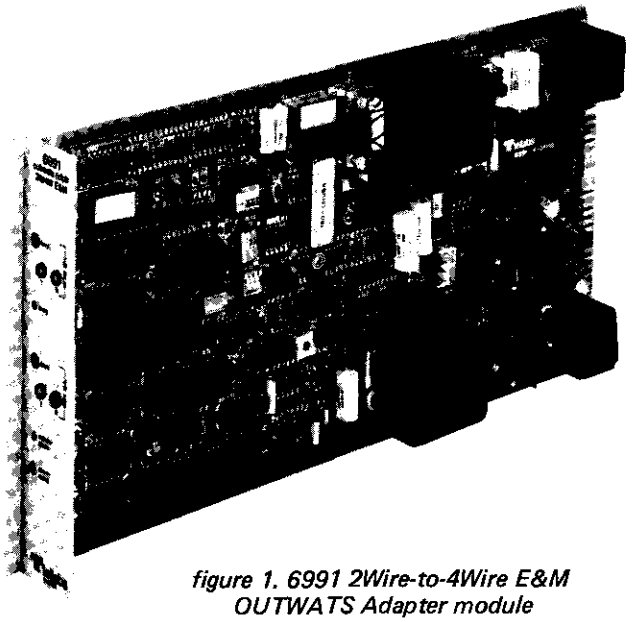


figure 1. 6991 2Wire-to-4Wire E&M OUTWATS Adapter module

1.05 Adjustable front-panel level controls are provided for both the transmit and receive channels to permit 2wire level coordination with the required −16dBm transmit and +7dBm receive levels at the module's 4wire ports. In the receive channel, from 4 to 22dB of loss is available; in the transmit channel, from 4 to 30dB of loss is available.

1.06 On the 2wire side, the 6991 module accommodates up to 2000 ohms of loop resistance. Switch options condition the module for loop-start or ground-start operation, 2wire port impedance, and NBO capacitance values. When the associated station goes off-hook, the 6991 provides precise dial tone and receives and stores the called number (up to 10 digits) from either a rotary-dial or DTMF telephone set.

1.07 After receiving a valid dialed number, the 6991 seizes the trunk toward the CO switch by busying its M lead. It then waits for dial control supervision from the CO switch. When the 6991 receives a valid delay-dial or wink signal, it transmits the stored number to the CO switch. The module can be switch-optioned to transmit the stored number either as MF tones over the 4wire transmit path, or as dial pulses on the M lead. If a valid delay-dial or wink signal is not received within approximately 10 seconds, the 6991 applies reorder (fast busy) tone toward the station and provides a "stuck sender" alarm signal output, indicated by lighting of the *sender alarm* LED on the 6991's front panel.

1.08 The 6991 provides a maximum interdigital timeout of approximately 10 seconds while collecting the dialed digits. If this time is exceeded, the module applies reorder tone toward the 2wire station. After application of reorder tone, the customer must go on-hook for at least 1 second before dial tone is reapplied. The 6991 processes the dialed digits as they are received. If an invalid digit is received, the module immediately applies reorder tone. Detailed digit-processing information is provided in paragraph 2.10.

1.09 After outpulsing the stored number toward the CO switch, the 6991 establishes a connection between the 2wire station and the 4wire transmission facility via its integral hybrid term set. This connection is maintained until a disconnect signal is received from the CO switch or until the station goes on-hook.

1.10 Upon receiving answer supervision from the switch, the 6991 reverses loop battery on the 2wire side and provides an output on its answer lead for usage-metering purposes.

1.11 The 6991 provides switch-selectable Type I or Type II E&M signaling interface. The module also derives simplex leads at its 4wire ports for DX signaling connections, and A and B leads on the 2wire side for station battery connection. Switched maintenance access system (SMAS) leads are provided for automated testing via the A, B, A1, B1, E, and M leads.

1.12 The 6991 module mounts in one position of the Tellabs Type 16 Mounting Shelf, versions of which are available for 19-inch and 23-inch relay rack installation. Both versions mount 12 modules and occupy 4 vertical mounting spaces (7 inches) in a standard relay rack. The Shelves are optionally available either unwired, equipped with jumpers to bypass switched-access testing points, completely universally wired, or universally wired with a connectorized backplane.

1.13 The 6991 operates from nominal –48Vdc filtered, ground-referenced battery supply. Maximum current requirements range from 120mA when idle to 160mA (plus loop current) when busy.

2. application

2.01 The 6991 2Wire-to-4Wire E&M OUTWATS Adapter module allows OUTWATS service to be provided to a customer directly from a toll center without the need for routing the OUTWATS line through an intermediate Class 5 end office. Typically, OUTWATS service is provided through a local Class 5 switch that provides conventional line supervision, including dial tone, call supervision, and usage metering, with access to the DDD network via a toll-originating trunk. The 6991 allows an OUTWATS customer to be directly connected to the toll network for WATS service, thus bypassing the local office and reducing toll-originating traffic.

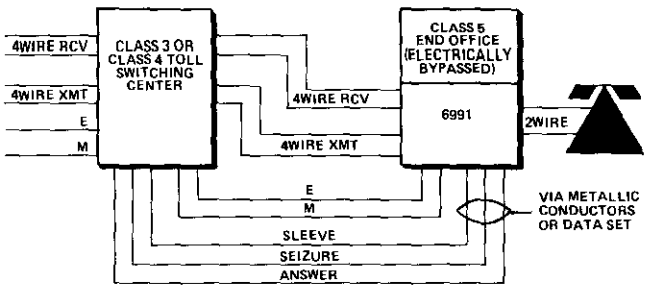


figure 2. 6991 located in Class 5 end office

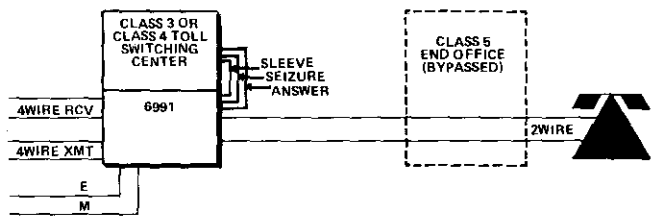


figure 3. 6991 located in Class 3 or Class 4 toll switching center

2.02 The 6991 module can be physically located in either a Class 5 end office (figure 2) or in the toll office (figure 3). Because WATS lines are usually high-usage lines, their routing through a Class 5 switch can cause blocking. With the 6991, the switch at the Class 5 end office can be bypassed, and the WATS customer can be connected directly to a 4wire E&M trunk going to a Class 3 or Class 4 toll office.

2.03 Another application of the 6991 is in a time-of-day billing system for WATS customers (as required by the FCC). One way to implement this system is by using one or more 6991 OUTWATS Adapters in conjunction with Tellabs 3228 Data Sets, as shown in figure 4. The 6991's seizure and answer (usage-metering) leads are routed to the 3228 Data Set, which transmits the usage-metering data via an interoffice facility to another 3228 at the other end. The usage-metering data (including time-of-day usage) can then be analyzed by the centralized automatic message accounting (CAMA) equipment.

2wire interface

2.04 The 2wire (station-side) interface is accomplished via the 6991's integral toll-grade hybrid terminating set. This hybrid provides balanced switch-selectable 600 or 900-ohm (in series with 2.15μF) 2wire terminating impedance to permit interface with various facilities and equipment. The 600-ohm option is normally selected when the 6991 interfaces nonloaded cable. The 900-ohm option is normally used to interface loaded cable. The hybrid derives A and B leads to accommodate loop current, if required. Also provided are A1 and B1 leads for SMAS testing purposes.

network build-out capacitance

2.05 The 6991 module's hybrid may be switch-optioned to function either with its own internal compromise balance network or with a separate

precision balance network (PBN). The integral network build-out (NBO) capacitors are connected across the balance port to compensate for capacitance of office cables or associated gain devices. From 0 to 0.115μF of NBO capacitance, in 0.005μF increments, can be switch-optioned into the circuit to maximize transhybrid loss.

2.06 Some applications of the 6991 may require hybrid balance (transhybrid loss) greater than that achievable via the module's internal compromise balance network. For these applications, the compromise network may be switch-optioned out of the circuit and a Tellabs 993X Precision Balance Network (PBN) subassembly plugged into a receptacle on the 6991's printed circuit board. The 993X subassemblies are available in several versions to approximate the impedances of specific transmission facilities and equipment. Refer to the Tellabs 993X PBN Practice for details. If desired, an external PBN module, such as a Tellabs 423X Precision Balance Network module, can also be used for this purpose, as external balance network leads are provided on the 6991.

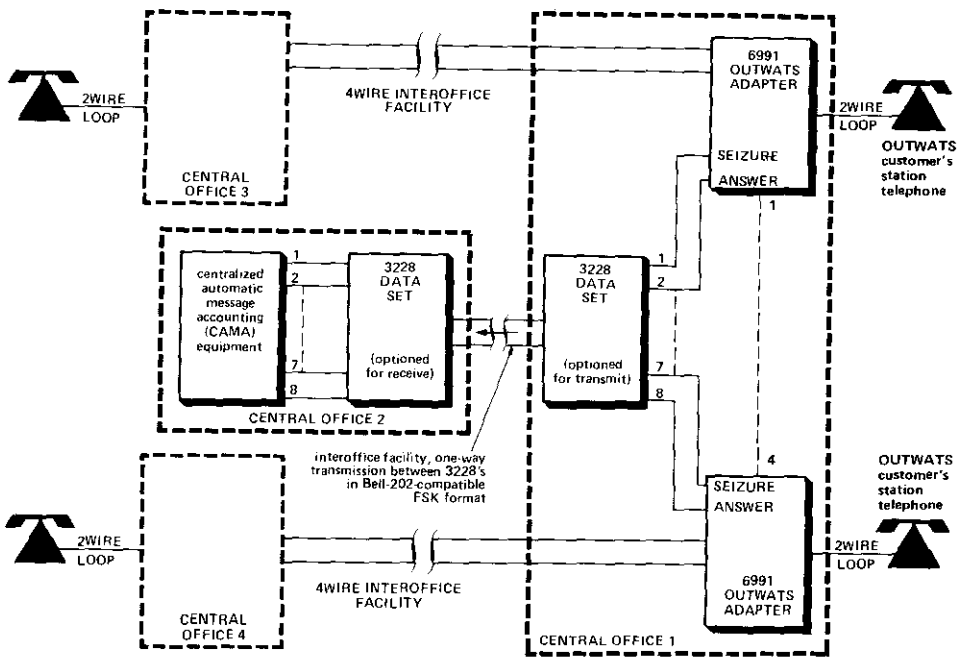


figure 4. Time-of-day billing application for 6991 OUTWATS Adapter

4wire interface and level control

2.07 The 6991 is designed to interface the 4wire transmission facility at conventional −16dBm transmit and +7dBm receive levels. The typical 2wire loop level (toward the station) is 0dBm. From 4 to 30dB of loss can be introduced into the transmit channel via the 6991's front-panel *4W XMT level* control. From 4 to 22dB of loss can be introduced into the receive channel via the 6991's front-panel *2W RCV level* control.

operation

2.08 The 6991 can be conditioned via switch option for loop-start or ground-start operation on the 2wire side. When the loop-start option is selected, dial tone is provided whenever an off-hook occurs. When the ground-start option is selected, the ring lead of the 2wire side must be grounded for at least 100ms before a tip-lead ground is provided toward the 2wire loop. After providing this tip-lead ground, if an off-hook is detected, the 6991 transmits dial tone (350 + 440Hz) at −13dBm0 toward the station.

2.09 While collecting digits, the 6991 allows a maximum interdigital interval of approximately 10 seconds before timing out. If this 10-second limit is exceeded, the 6991 clears its internal register and sends reorder (fast busy) tone toward the 2wire station. After applying reorder tone, the module looks for an on-hook signal. If the module is optioned for ground-start operation and the calling party remains off-hook for more than 20 seconds, the module removes ground from the tip side of the loop. Tip ground is not reapplied until another ring-ground seizure is received. If the module is optioned for loop-start operation and the caller remains off-hook for more than 20 seconds, the 6991 removes tip ground for approximately 1 second on the 2wire side and then immediately regrounds the tip lead. If the calling station is still off-hook, dial tone is applied.

2.10 The 6991 receives the full complement of dialed digits before seizing the toll office via conventional dial-control supervision. The module then outpulses the stored digits. This outpulsing information is listed in table 1 and can be summarized as follows:

A. If a zero is received as the first digit, the 6991 recognizes it as the only digit to be received and sends it toward the CO switch.

B. If a "1" is received as the first digit, the 6991 recognizes it as valid, but absorbs it and waits for other digits. This allows customers who are accustomed to dialing "1" as an initial access digit to continue doing so. (However, the 1 is not required by the 6991.)

C. If the second digit is other than a zero or a "1," the 6991 accepts a total of only seven digits and then outpulses them.

D. If the second digit is a "1" and the third digit is also a "1," the 6991 immediately outpulses the three received digits.

E. If the third digit is other than a "1" and if the second digit was a zero or a "1," the 6991

waits until a total of 10 digits are received and then outpulses them.

F. If any invalid character (e.g., an "*") is dialed as any digit, the 6991 immediately provides reorder (fast busy) tone.

G. If a "#" is dialed, the 6991 recognizes it as an end-of-dialing signal and starts the outpulsing procedure with whatever number of digits it has received at that time.

	order (position) of dialed digits				
	1	2	3	4-10	action of 6991
digits dialed	0				recognizes the zero as request for operator, and outpulses the zero toward the CO switch
	1				recognizes as a valid digit when dialed in first position; however, it is absorbed and not transmitted
	2 through 9	1	1		outpulses the three received digits (such as an emergency number) toward the CO switch
	2 through 9	2 through 9	X	X	accepts a total of seven digits and then outpulses them toward the CO switch
	2 through 9	0 or 1	0, 2 through 9	X	accepts a total of ten digits and then outpulses them toward the CO switch
	*	*	*	*	recognizes as invalid character; immediately provides reorder (fast busy) tone when dialed as any digit
	#	#	#	#	recognizes as end-of-dialing signal; starts the outpulsing procedure with the digits received up to that time.

Note 1: *X = any valid digit (0 through 9)*
Note 2: *Where local (seven-digit) numbers use 0 or 1 in the second position, a "#" must be dialed as an eighth digit to complete the call.*

table 1. 6991 dialing information

2.11 Because the 6991 is a microcomputer-controlled module, its digit-processing format can be modified relatively easily via a replaceable EPROM to modify the unit's operation for other applications. Please call Tellabs Customer Service at your Tellabs Regional Office or at our U.S. or Canadian Headquarters (see paragraph 7.02) for specific application information if your digit-processing requirements change.

2.12 On the 2wire side, the 6991 can accept dialed digits from either a dual-tone multifrequency (DTMF) or a rotary dial telephone set. On the 4wire E&M side, a switch option conditions the module for either multifrequency (MF) tone or dial-pulse (DP) signaling toward the Class 3 or Class 4 toll center. When the dial-pulse option is selected, the digits are outpulsed on the M lead after a valid wink or delay-dial signal is received. The pulses are sent at a rate of 10 ± 0.5 pps with 60% break and 40% make times.

digit	frequencies (Hz)	duration
1	700 + 900	68 ± 7 ms
2	700 + 1100	68 ± 7 ms
3	900 + 1100	68 ± 7 ms
4	700 + 1300	68 ± 7 ms
5	900 + 1300	68 ± 7 ms
6	1100 + 1300	68 ± 7 ms
7	700 + 1500	68 ± 7 ms
8	900 + 1500	68 ± 7 ms
9	1100 + 1500	68 ± 7 ms
0	1300 + 1500	68 ± 7 ms
KP digit (beginning-of-pulsing signal)	1100 + 1700	100 ± 10 ms
ST digit (end-of-pulsing signal)	1500 + 1700	68 ± 7 ms

Note: *All MF frequencies are transmitted with ± 1.5% accuracy.*

table 2. Specifications of MF tones used in 6991

2.13 When the MF outpulsing option is selected, the 6991 sends the dialed number in proper combinations of MF frequencies with a duration of 68 ± 7ms for each dialed digit. Duration of the KP (start-of-dialing) digit is 100 ± 10ms; duration of the ST (end-of-dialing) signal is 68 ± 7ms. These frequencies are sent at a level of −23dBm (nominal). The specifications for MF tones are in accordance with Bell System standards, as listed in table 2.

2.14 Three usage-metering leads are available on the 6991. Information from these leads is used for toll-center routing purposes and/or billing. Whenever the customer's station telephone goes off-hook, a transistor ground is provided on the sleeve lead. After the 6991 seizes the 4wire trunk, a transistor ground is provided on the seizure lead. When the called party answers, a transistor ground on the answer lead is provided. All three leads must be sourced at the toll center. The seizure and answer leads should be limited to 20mA of current, and the sleeve lead should be limited to 50mA of current.

2.15 If a delay-dial or a wink signal is not received from the Class 3 or Class 4 toll center within approximately 10 seconds of seizure, the 6991 recognizes this as an alarm condition. Relay contact closure is then provided by the 6991 to activate a CO alarm (e.g., an audible and/or visible alarm). A visible alarm indication is also provided on the 6991 module itself through the lighting of its front-panel sender alarm LED. A front-panel alarm reset pushbutton on the 6991 allows the sender alarm to be reset at the module's location. Remote alarm reset can also be accomplished via an external lead.

2.16 After receiving answer supervision from the Class 3 or Class 4 toll center, the 6991 reverses the battery on the 2wire station loop. If the called party disconnects first, the module resets the reverse-battery condition on the 2wire side, waits for 10 seconds (nominal), removes tip ground on the 2wire side for 1 second (nominal), and then resets its microcomputer. If the 2wire side is still off-hook, the module either provides dial tone (when optioned for loop-start operation) or waits

for ring ground (when optioned for ground-start operation).

2.17 The 6991 derives simplex leads from center taps on the 4wire-side transformers. These leads are used for DX signaling over a metallic facility between the module and a Class 3 or Class 4 toll center. The unit also provides switch-selectable Type I or Type II E&M signaling interface. The Type I (nonlooped) E&M interface is used for electromechanical switching offices and the Type II (looped) E&M interface is used for electronic switching offices.

2.18 The 6991 provides switched maintenance access system (SMAS) leads for testing on the A, B, A1, B1, E and M leads. The primary use of these leads is for testing by computerized maintenance equipment at the toll center. This equipment can check the signals generated by the 6991 module and the integrity of the facility interfaced by the 6991.

3. installation

inspection

3.01 The 6991 2Wire-to-4Wire E&M OUTWATS Adapter module should be visually inspected upon arrival in order to find possible damage incurred during shipment. Check for loose or broken components. 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

Caution: *The 6991 uses a mercury-wetted relay for M-lead signaling. Before installation, the module should be held in an upright position and tapped gently on a hard surface to ensure that the mercury is properly positioned within the relay. Once tapped, the module should be kept in an upright position until installation and installed in a vertical, upright position.*

3.02 The 6991 module mounts in one position of the Tellabs Type 16 Mounting Shelf, which is available in configurations for both 19-inch and 23-inch relay-rack installation. The 6991 can also be mounted in one position of the Tellabs 267S Signaling and Terminating Assembly, a two-module wallmounted enclosure designed for installation at customer locations (see the 267S Practice for details). The module plugs physically and electrically into a 56-pin connector at the rear of the Shelf or Assembly.

installer connections

3.03 If a Type 16 Shelf without a connectorized backplane is used, external connections are made via wire wrapping to the 56-pin connector at the rear of the module's shelf position. Pin numbers are found on the body of the 56-pin connector. Before making any connections to the shelf, ensure that power is **off** and modules are **removed**. Modules should be inserted into the shelf only **after** they are properly optioned and **after** wiring is completed. Table 3 lists external connections required when nonconnectorized Type 16 Shelves are used. Figure 5 shows the required external connections for Type I and Type II E&M signaling interface, both with and without SMAS connections.

connect:	to pin:
4W RCV IN T (4wire receive input tip)	55
4W RCV IN R (4wire receive input ring)	53
4W XMT OUT T (4wire transmit output tip)	3
4W XMT OUT R (4wire transmit output ring)	1
2WIRE T (2wire tip)	7
2WIRE R (2wire ring)	5
SXR (facility receive simplex lead)	41
SXT (facility transmit simplex lead)	9
−BATT (−48Vdc filtered, ground-referenced input)	15
GND (ground)	25 and 26
EXT. BAL. NET. (external precision balance network)	49 and 51
M1 (M1 lead) (see figure 5)	18
MA (MA lead) (see figure 5)	19
M1 (M1 lead) (see figure 5)	20
MB (M battery lead used for Type II signaling) (see figure 5)	32
E1 (E1 lead) (see figure 5)	22
E (E lead) (see figure 5)	21
E1 (E1 lead) (see figure 5)	24
EG (E-lead ground used for Type II signaling) (see figure 5)	28
A1 (A1 lead) (see note)	38
A (A lead) (see note)	40
B1 (B1 lead) (see note)	34
B (B lead) (see note)	36
SLEEVE (usage-metering lead)	17
SEIZURE (usage-metering lead)	39
ANSWER (usage-metering lead)	13
ALARM COM. (stuck-sender relay common contact)	43
ALARM N.C. (stuck-sender relay normally closed contact)	45
ALARM N.O. (stuck-sender relay normally open contact)	47
REMOTE ALARM RESET (external alarm reset lead)	46

Note: *For SMAS applications, wire pins 38, 40, 34, and 36 to proper SMAS access points. For non-SMAS applications, wire pin 38 to pin 40 and wire pin 34 to pin 36.*

table 3. External connections to 6991

3.04 If Type 16 Shelves with connectorized backplanes are used, external connections are made via plug-ended cables that are mated to connectors on the backplane of the shelf. Refer to the appropriate Tellabs Practice for details. Again, modules should be put into place only after verifying wiring, fusing, and option selection.

3.05 If the 6991 is to be mounted in a 267S Assembly, no external connections to the module itself are required because these connections are prewired. For installer connections to the Assembly itself, please refer to the Tellabs 267S Assembly Practice.

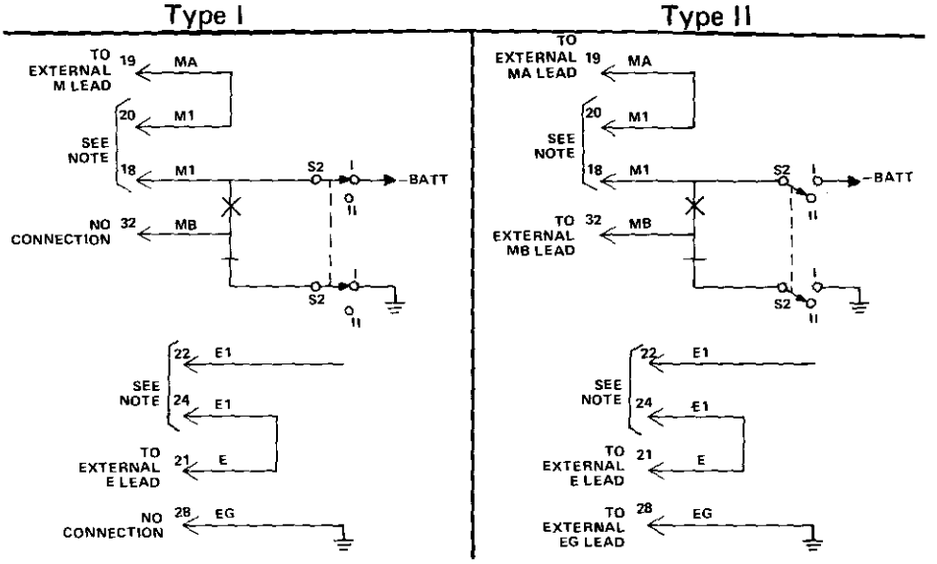
Note: *When using the 6991 in an* **Issue 1** *267S Assembly (part number 81267S), a Tellabs 8012 DC Power Supply is required. The 8012 is not required, however, when using the 6991 in an* **Issue 2** *267S Assembly (part number 82267S).*

option selection

3.06 All 6991 options are selected via slide or DIP switches located as shown in figure 6. Table 4 lists all options and indicates the option choices, which are explained below. The 6991 should be completely optioned and its optioning verified before alignment is attempted.

Type I or Type II E&M signaling interface

3.07 Switch *S2* is a two-position slide switch located on the 6991's printed circuit board. Set *S2* to the *I* position for Type I E&M signaling interface; set *S2* to the *II* position for Type II interface.



Note: *For SMAS applications, wire pins 20, 18, 22, and 24 to proper SMAS access points. For non-SMAS applications, wire pin 20 to pin 18 and wire pin 22 to pin 24.*

figure 5. Type I and Type II E&M signaling interface, with and without SMAS connections

2wire port impedance

3.08 Switches *S3* and *S6* are two-position slide switches that are used to select 600-ohm or 900-ohm 2wire port impedance. Set both *S3* and *S6* to either the *600* or *900* position, as required. Generally, 600 ohms is used for nonloaded cable or direct station interface, while 900 ohms is used for loaded cable.

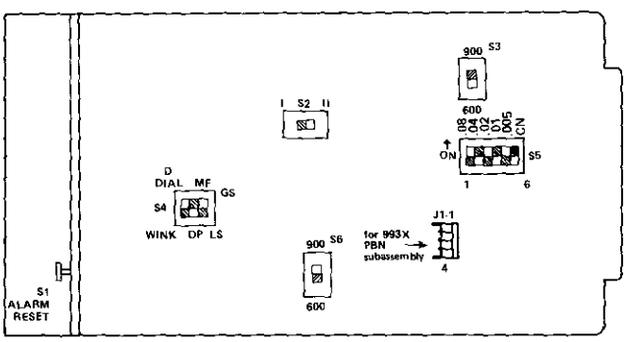


figure 6. 6991 option switch locations

loop-start or ground-start operation

3.09 Switch *S4-1* is the first segment of three-position DIP switch S4. If ground-start operation is desired on the 2wire side, set *S4-1* to the *GS* position. If loop-start operation is desired, set *S4-1* to the *LS* position.

dial-pulse or multifrequency tone operation

3.10 Switch *S4-2* is the second segment of three-position DIP switch *S4*. If dial-pulse operation (outpulsing on the M lead) is desired on the 4wire side, set *S4-2* to the *DP* position. If multifrequency tone transmission is desired, set *S4-2* to the *MF* position.

wink or delay dial signal

3.11 Switch *S4-3* is the third segment of three-position DIP switch S4. If the toll center sends a wink as an answer-back signal after trunk seizure,

switch	option	function
S1	ALARM RESET	resets stuck-sender alarm when front-panel pushbutton is depressed
S2	I or II	selects Type I or Type II E&M signaling interface
S3 and S6	600 or 900	select 600 or 900-ohm impedance at 2wire port
S4-1	GS or LS	selects ground-start operation when on (closed) or loop-start operation when off (open)
S4-2	MF or DP	selects multifrequency (MF) facility outpulsing when on (closed) or dial-pulse facility outpulsing when off (open)
S4-3	D. DIAL or WINK	selects delay-dial operation when on (closed) or wink operation when off (open)
S5-1 S5-2 S5-3 S5-4 S5-5	on (closed) or off (open)	0.08μF 0.04μF 0.02μF 0.01μF 0.005μF when on, introduce indicated amounts of NBO capacitance
S5-6	on (closed) or off (open)	inserts internal compromise balance network into circuit when on (closed) or selects external precision balance network when off (open)

table 4. 6991 switch options

set *S4-3* to the *WINK* position. If the toll center's answer-back signal is of the delay-dial type, set *S4-3* to the *D. DIAL* position.

NBO capacitance

3.12 Positions *1* through *5* of six-position DIP switch *S5* may be set as necessary to introduce from 0 to 0.115μF of NBO capacitance in 0.005μF increments. Total NBO capacitance introduced is the sum of switches *S5-1* through *S5-5* set to the *on* (closed) position. Capacitance values are shown next to their respective *S5* positions in figure 6; please note, however, that they are not screened on the module's printed circuit board. Position *6* of switch *S5* permits use of either the 6991's internal compromise balance network or an external or plug-on precision balance network (PBN). Set *S5-6* to the *on* (closed) position (indicated as the *CN* position in figure 6) if the internal compromise network will be used; set *S5-6* to the *off* (open) position if an external PBN module or a Tellabs 993X PBN subassembly will be used.

stuck-sender alarm reset

3.13 The stuck-sender alarm can be manually reset by depressing the *alarm reset* switch located on the 6991's front panel. The alarm can also be remotely reset by providing an external ground on the 6991's remote-alarm-reset lead, pin 46.

alignment

3.14 Alignment of the 6991 consists of adjusting the front-panel 2wire receive level potentiometer and 4wire transmit level potentiometer to coordinate the standard −16dBm transmit and +7dBm receive levels with terminal-side levels, and introducing NBO capacitance to maximize transhybrid loss. Before aligning the 6991, verify that the module is optioned for 600-ohm 2wire terminating impedance and loop-start operation, and that all other optioning is correct.

3.15 Access to the appropriate ports of the 6991 is conveniently provided by means of a Tellabs 9807 Card Extender or an external jackfield. (If you are using a 9807, its Tellabs Practice, section 819807, will be helpful during the following procedure.) Using a properly terminated transmission measuring set (TMS), align the module as indicated below.

3.16 **receive section:**

A. Condition the transmit portion of the TMS for 1000Hz tone output at +7dBm into 600 ohms. Connect this signal to the 6991's 4wire receive input port (pins 55 and 53) or to the 9807's *rcv SF in* jack.

B. Condition the receive portion of the TMS for 600-ohm terminated measurement and connect it either to the 6991's *2W RCV T* and *R* test points, to the 6991's 2wire port (pins 7 and 5), or to the 9807's *2W in* jack.

C. Adjust the 6991's *2W RCV level* control to achieve the 2wire output level specified on the circuit layout record (CLR).

3.17 **transmit section:**

Note: *Alignment of the 6991's transmit section requires a TMS whose transmit portion has dial-through and hold capability.*

A. Condition the transmit portion of the TMS for 1000Hz tone output at the CLR-specified 2wire input level into 600 ohms. Connect this signal either to the 6991's *2W RCV T* and *R* test points, to the 6991's 2wire port (pins 7 and 5), or to the 9807's *2W in* jack.

B. Condition the receive portion of the TMS for 600-ohm terminated measurement and connect it either to the 6991's *4W XMT T* and *R* test points, to the 6991's 4wire transmit output port (pins 3 and 1), or to the 9807's *xmt SF out* jack.

C. Connect a handtest telephone set (either rotary-dial or DTMF) to the dial input on the TMS.

D. Place the TMS in the "dial" mode.

E. Go off-hook with the test telephone and dial a "0."

F. Place the TMS in the "hold" mode.

G. Apply ground to the 6991's E lead and then immediately remove it.

H. Adjust the 6991's *4W XMT level* control to achieve a level of −16dBm, as indicated on the TMS.

3.18 Reoption the 2wire port impedance (via switches *S3* and *S6*) to 900 ohms if the 2wire port interfaces loaded cable. Also reoption switch *S4-1* to *GS* if ground-start operation is required.

network build-out capacitors

3.19 Optimum performance of the module's integral hybrid terminating set may require adjustment of the module's NBO capacitors to compensate for the capacitance of the cable pair connected to the 6991's 2wire port.

3.20 Access to the appropriate 6991 ports requires either a Tellabs 9807 Card Extender or an external jackfield.

3.21 Prior to adjusting the NBO capacitance, perform the following steps:

A. Ensure that the 6991's transmit and receive levels are properly adjusted as directed in paragraphs 3.16 and 3.17.

B. Verify that the 6991's 2wire port impedance is properly optioned (via switches *S3* and *S6*) for either 600 or 900 ohms.

C. Ensure that the station equipment is connected to its cable pair and that the station cable pair is connected to pins 7 and 5 of the 6991.

D. Set option switch *S5-6* to the *CN* position.

3.22 Begin the NBOC adjustment as follows:

A. Have the station placed off-hook. It must remain off-hook for the duration of the adjustment procedure.

B. Have the station dial a "0."

C. Apply ground to the E lead and then immediately remove it.

3.23 The balance of the NBOC adjustment can be completed with either a TMS or a return loss test set (RLTS). If a TMS is being used, proceed as directed in paragraph 3.24; if an RLTS is being used, proceed as directed in paragraph 3.25.

3.24 **If using a TMS:**

A. Condition the transmit portion of the TMS for 2000Hz test tone output at +7dBm into 600 ohms. Connect this signal to the 6991's 4wire receive input port (pins 55 and 53) or to the 9807's *rcv SF in* jack.

B. Condition the receive portion of the TMS for 600-ohm terminated measurement and connect it to the 6991's *4W XMT T* and *R* test points or to the 9807's *xmt SF out* jack.

C. Switch NBO capacitance into or out of the circuit via switches *S5-1* through *S5-5* to achieve the lowest possible level reading on the TMS (i.e., to maximize transhybrid loss).

D. A more precise adjustment may be achieved by varying the test frequency over the voice band (300 to 3000 Hz) as the NBO capacitors are switched into or out of the circuit.

3.25 **If using an RLTS:**

A. Condition the transmit portion of the RLTS for a +7dBm test signal output into 600 ohms. Connect this signal either to the 6991's 4wire receive input port (pins 55 and 53) or to the 9807's *rcv SF in* jack.

B. Condition the receive portion of the RLTS for a 600-ohm terminated measurement and connect either to the 6991's *4W XMT T* and *R* test points, to the 6991's 4wire transmit port (pins 3 and 1), or to the 9807's *xmt SF out* jack.

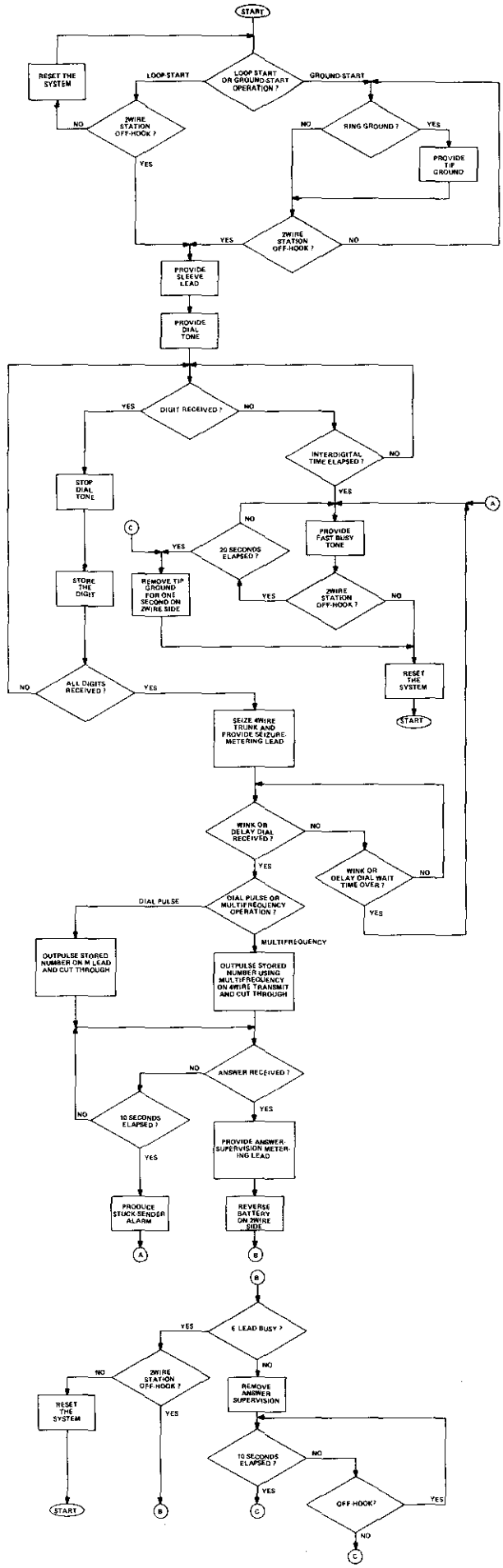
C. Switch NBO capacitance into or out of the circuit via switches *S5-1* through *S5-5* to achieve the lowest possible level reading on the TMS (i.e., to maximize transhybrid loss).

precision balance network adjustment

3.26 If an optional PBN (either a Tellabs 993X PBN plug-on subassembly or a Tellabs 423X PBN module) is being used with the 6991, please refer to the appropriate 993X or 423X Tellabs Practice for optioning and adjustment information.

4. circuit description

4.01 To provide the clearest possible understanding of the operation of the 6991 2Wire-to-4Wire E&M OUTWATS Adapter module, a function sequence chart (figure 7) that illustrates sequential operation of the module in loop-start and ground-start operation is presented in lieu of a more conventional circuit description. This chart is arranged in a computer-programming flowchart format. Lines with arrowheads indicate the flow of events. A diamond-shaped block indicates that a



page 8 *figure 7. 6991 function sequence chart*

decision is made at that point; one path or the other will be followed. A rectangular block indicates the circuit condition at a given point; no decision is required at that point, and the next block follows immediately. Reference to the 6991 block diagram (section 5 of this Practice) may aid in understanding the sequence chart.

4.02 The sequence chart is intended to familiarize you with the operation of the 6991 for engineering, application, and troubleshooting purposes. However, attempts to test or troubleshoot the 6991 internally are not recommended. Procedures for recommended testing and troubleshooting in the field should be limited to those prescribed in section 7 of this Practice.

6. specifications

2wire-port terminating impedance
switchable 600 or 900 ohms in series with 2.15μF, balanced

4wire-port terminating impedances (xmt out and rcv in)
600 ohms, balanced

attenuation/gain range
with 4wire receive level at +7dBm, 2wire receive level adjustable from +3 to −15dBm
with 2 wire transmit level at 0dBm, 4wire transmit level adjustable from −4 to −30dBm

transhybrid loss
35dB ERL minimum

2wire echo return loss
30dB minimum

4wire echo return loss
20dB minimum

longitudinal balance
2wire port: 55dB minimum, 400 to 4000Hz
4wire ports: 60dB minimum, 400 to 4000Hz

balance network
internal compromise network, 604 or 905 ohms in series with 2.15μF

NBO capacitance
0 to 0.155μF in 0.005μF increments, switch-selected

maximum output at 4w xmt out port
no visible clipping at +5dBm

maximum E-lead-to-ground resistance
2000 ohms

maximum external loop resistance
2000 ohms

maximum ring ground resistance
1000 ohms

dial tone
350Hz +440Hz ±2Hz at −13dBm0 ±1dBm per frequency

reorder (fast busy) tone
480Hz +620 ±2Hz at −24dBm0 ±1dBm per frequency

interdigital timeout while receiving digits
approximately 10 seconds

dial pulse receiver on 2wire side
8 to 12pps, 35% minimum break at 10pps

M-lead pulsing
10 ±0.5pps at 60% ±2% break with interdigital time of 700 ±35ms

multifrequency outpulsing duration
KP = 100 ±10ms, all other digits = 68 ±7ms

multifrequency output level
−23dBm ±2dBm per frequency

maximum wink or delay-dial signal delay after trunk seizure
10 ± 1 seconds

dial tone connect time
350 ±50ms for loop start, 450 ±50ms for ground start

metering leads
off-hook to sleeve ground = 350 ±50ms for loop start, 450 ±50ms for ground start
seizure to M-lead busy = less than 2ms
E-lead answer to answer-metering lead = 40ms ±10ms

stuck-sender alarm activation time after trunk seizure and no wink
10 seconds ±1 second

stuck-sender relay contact rating
maximum current: 1 ampere
maximum voltage: ±200Vdc

voltage requirements
−44Vdc to −56Vdc, filtered, ground-referenced

current requirements
120mA at idle, 160mA maximum excluding loop current

maximum load current on sleeve lead
50mA

maximum load current on answer lead and seizure lead
20mA

operating environment
32° to 104°F (0° to 40°C), humidity to 95% (no condensation)

dimensions
6.71 inches (17.04cm) high
1.42 inches (3.61cm) wide
12.94 inches (32.87cm) deep

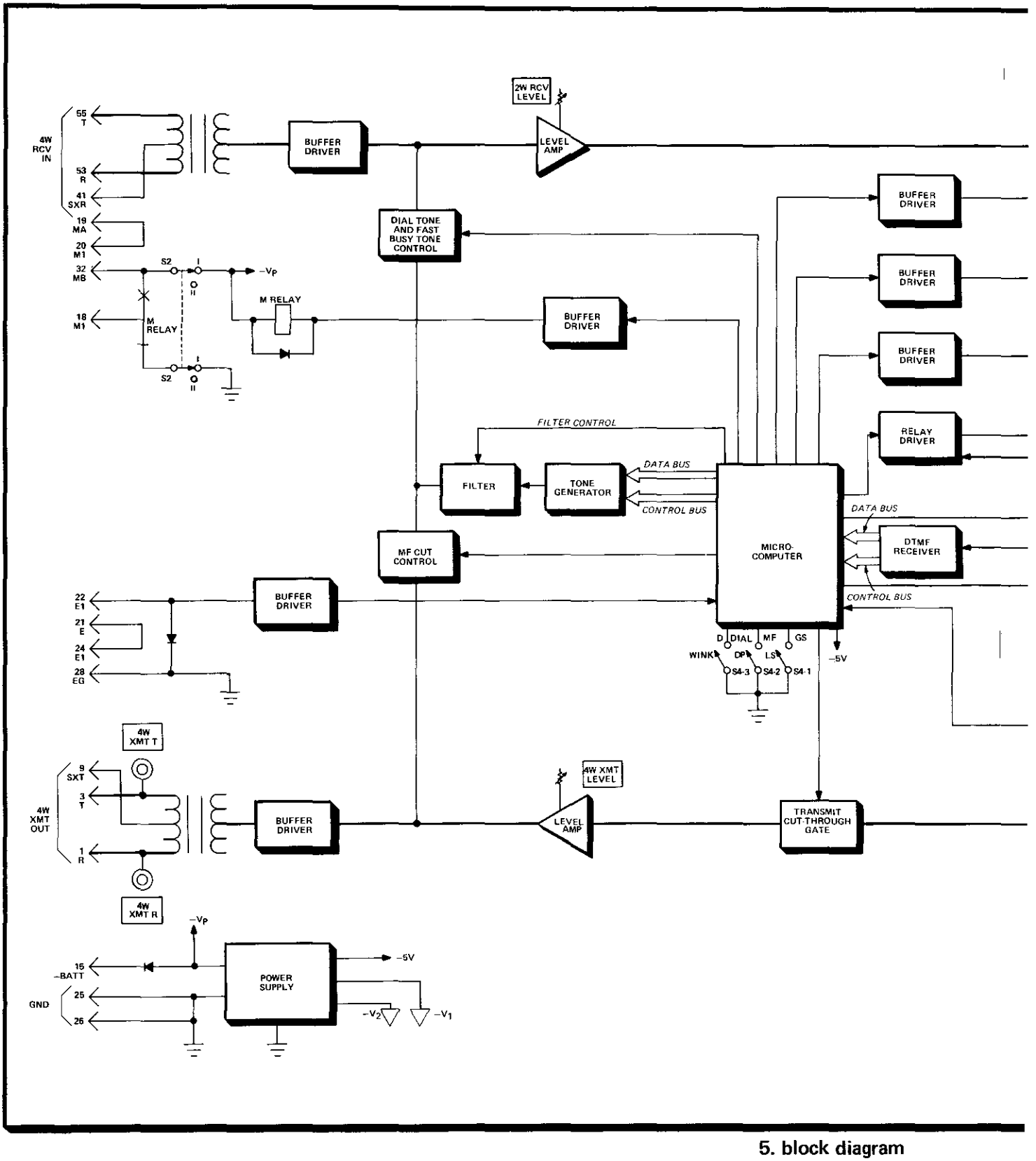
weight
32 ounces (907 grams)

mounting
19-inch or 23-inch relay rack via one position of Tellabs Type 16 Mounting Shelf; may also be mounted in one position of Tellabs 267S Signaling and Terminating Assembly

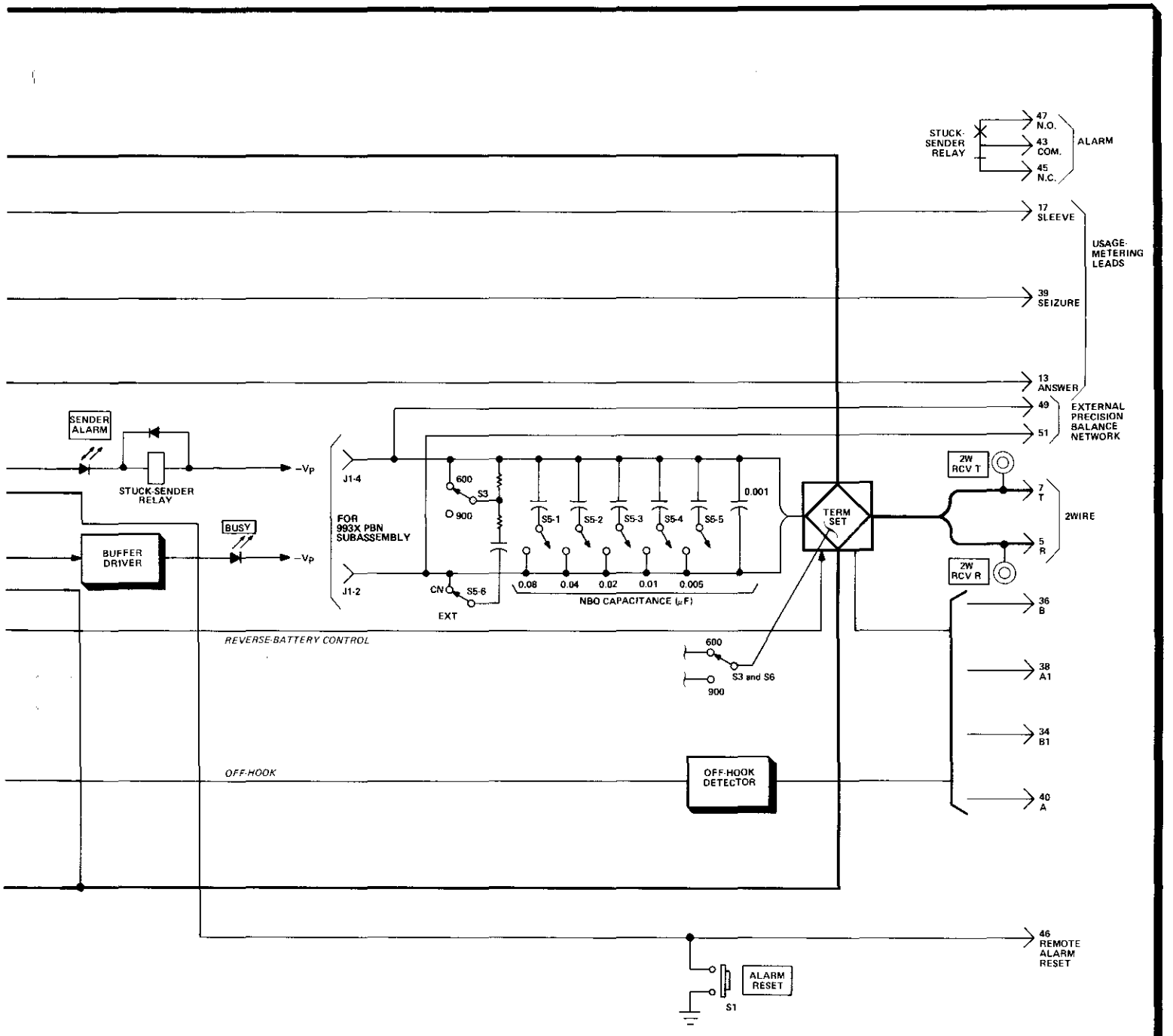
7. testing and troubleshooting

7.01 The Testing Guide Checklist in this section may be used to assist in the installation, testing, or troubleshooting of the 6991 2Wire-to-4Wire E&M OUTWATS Adapter. 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 6991 module. Unauthorized testing or repairs may void the module's warranty.

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:



5. block diagram



6991 2Wire-to-4Wire E&M OUTWATS Adapter 816991

US central region: (312) 969-8800
US northeast region: (412) 787-7860
US southeast region: (305) 645-5888
US western region: (213) 595-7071
Lisle Headquarters: (312) 969-8800
Mississauga Headquarters: (416) 624-0052

7.03 If a 6991 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 6991 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 8X6991 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 6991 in the replacement module's carton, sign the packing slip included with the replacement module, 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 6991 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 11
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

test	test procedure	normal result	if normal conditions are not met, verify:
dial-tone and fast-busy-tone generation	Go off-hook on 2wire side.	Dial tone heard for first 10 seconds; fast busy tone heard for next 20 seconds ☐. Front-panel *busy* LED lighted ☐.	Power ☐. Wiring ☐. Shorting straps in place between pins 34 and 36 and pins 38 and 40 ☐. Proper setting of *S4-1* for loop-start or ground-start operation ☐. If dial tone and/or fast busy tone are not present, replace 6991 and retest ☐.
dialed-number storage and transmission with dial-pulse outpulsing (via M lead)	Select dial-pulse outpulsing (on M lead) via switch *S4-2*. Connect test telephone on 2wire side. Go off-hook, receive dial tone, and dial office quiet termination number.	After number is dialed, number is outpulsed on M lead (this can be heard at 2wire station) ☐. When 4wire side answers, reverse battery is present on 2wire side ☐.	Proper setting of *S4-3* for delay-dial or wink operation ☐. Make sure either delay-dial or wink answer-back signal is received from 4wire side ☐. Replace 6991 and retest ☐.
dialed number storage and transmission with multi-frequency (2/6 MF) outpulsing	Select MF tone outpulsing via switch *S4-2*. Connect test telephone on 2wire side. Bridge TMS to monitor 4wire transmit output tip and ring. Go off-hook, receive dial tone, and dial office quiet termination number.	After number is dialed, MF tones can be heard on speaker of TMS ☐. When 4wire side answers, reverse battery is present on 2wire side ☐.	Proper setting of *S4-3* for delay-dial or wink operation ☐. Make sure either delay-dial or wink answer-back signal is received from 4wire side ☐. Replace 6991 and retest ☐.