Signalcrafters TECH, INC

USER'S MANUAL

MODEL 5493
(Formerly Model 2493)
DTMF MODEM

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SIGNALCRAFTERS MODEL 5493 DTMF MODEM

Contents

1. General, Functional

This manual provides circuit description, installation instructions, and testing procedures for the Model 5493 ASCII to DTMF Converter.

The Model 5493 is a Wescom 400/Tellabs Type 10 compatible plug-in module and occupies a single slot. Relay Expander cards are optional accessory items, which also use a single slot per card.

The 5493 convert DTMF tones to the ASCII characters, and ASCII characters to DTMF tones. The conversion is done automatically using the following sequence: D 1 2 3 4 5 6 7 8 9 * # A B C.

Each time a DTMF character is recognized by the 5493, an ASCII conversion is automatically done. The unit then sends the ASCII character out its RS232 output port and (re)starts the Interdigit timer. When the Interdigit timer completes a carriage return and line feed is sent to the RS232 output.

Each times an ASCII character is recognized by the 5493, it is stored in a 32-character ASCII input buffer and the Interdigit timer is (re)started. The ASCII input is terminated either by a carriage return or Interdigit timer completion. These characters are converted directly to DTMF and sent out pins 1 and 7 (non-DTMF characters are ignored).
The 5493 can receive ASCII characters as internal commands that result in no DTMF being transmitted. The modem's internal commands all begin with its address ABC followed by three control digits.

The 5493 works in conjunction with Model 5212 and 2212 Loopback Receivers. The modem is capable of generating measurement tones to remote 5212's. It can also send control commands to remote 5212's and then measure incoming tones.

The 5493 can produce selective call codes by receiving a 4, 5, or 6 digit internal command ASCII sequence. The tones can either be two-tone sequential or four-tone formats.

The unit allows for local control by using the keyboard for the 5493. This can substitute for ASCII input by using a "store and forward" mode. When the Interdigit timer completes after entering a string the modem receives the codes as though they were entered via the RS232 port.

The 5493 also provides for an Autoanswer/AutoDialer function. The 5493 recognize ringing current and send the ASCII message "RING" to the RS232 output. By using a relay, the line can be seized and a call can be made by sending the unit the ASCII dialing code sequence.

When set-up with a personal computer, the modem supplies an interface so any Signalcrafters card can be controlled. The 5493 are also compatible with software programs such as Status Monitor.

2. Inspection

Inspect the equipment thoroughly upon delivery. Report damages immediately to shipping carrier.

3. Mounting

The Model 5493 DTMF Modem is designed for plug-in compatibility with Wescom 400 series and Tellabs Type 10 mounting shelves and apparatus cases.

The Model 5452 Relay Expander Card is designed to mount in a second Wescom/Tellabs compatible slot. See the 5452-relay card manual for technical details.

4. Installer Connections

This section provides installer connection information for the 5493. The 5493 plugs into standard 56 pin card edge connectors normally used in Wescom 400 series and Tellabs Type 10 mounting facilities.

Refer to the programming section before placing the 5493 unit in continuous service.

4.1 Power Supply: The 5493 is available in 24VDC (positive, negative, or floating) version only. **When using earth grounded computer you MUST us isolated 24 VDC power supply (floating)**

4.2 The chart below lists installer connections for 5493 operation.

Pin	Function
1	Tone Output Tip
7	Tone Output Ring
22	DTMF Input Tip
28	DTMF Input Ring
17	Common Power Input
35	-24VDC Power Input
54	RS232 Input (From DB25 pin 2)
29	RS232 Output (to DB25 pin 3)
8	Tie to pin 56 when using an isolated 24VDC supply
56	RS232 GND (to DB25 pin 7)
49	+ Ring Detector
47	- Ring Detector

5452 RELAY CARD CONNECTIONS: The following table illustrates the appropriate hookup information for the relay expander card. Five wires connect the 5493 to its companion relay card. To control multiple relay cards (up to 8), simply daisy chain the additional relay cards together.

5493		**Relay Card**
Pin	Function	Pin
41	+DC Common	41
43	-Source	43
45	-5 VDC	45
50	Count	53
55	Reset	55

5. Programming

5.1 The 5493 have numerous field-programmable features. These are changed by two methods: dipswitch settings and program wires. This unit must be properly programmed before placing it into service. This section provides information so you can tailor the 5493 to your own application.

It is easier to change the following programming wires if the pc boards have been separated. To do this remove the three screws, which hold the microprocessor, board to the interface board beneath it. Then gently unplug the top board. CAUTION, with the top board removed avoid static electricity.

5.2 LINE LOADING AND 2-WIRE/4-WIRE CIRCUITS: These variables are programmed using the EIA color-coded wires located on the interface board near the large relay. Refer to the table below to connect a 2/4-wire interface and set the 600 or 900-ohm line loading.

2-WIRE Applications:

WIRE	COLOR	APPLICATION
ZA	Brown	600 or 900
ZB	Red	EXT
ZC	Orange	2W
ZD	Yellow	600 or 900 (top set only)
ZE	Green	600 or 900
DTMF	Blue	RX

4-WIRE Applications:

WIRE	COLOR	APPLICATION
ZA	Brown	4W only
ZB	Red	600 or 900
ZC	Orange	600 or 900 (top set only)
ZD	Yellow	600 or 900 (bottom set only)
ZE	Green	600 or 900
DTMF	Blue	RX or EXT** (DTMF tone input to pin 14)

5.3 AMPLIFIER/ATTENUATOR: The built-in amplifier/attenuator may be adjusted using the dipswitches located on the interface board to the left of the large relay. The desired gain or loss may be adjusted in 1 dB increments from –31 dB to +24 dB using these switches. These switches (SW2 and SW3) are labeled left to right as follows: -1, -2, -4, -8, -16, and +24. Combinations of switch settings can be used to achieve the desired gain or loss.

Set the switches to add algebraically to the loopback gain or loss desired. That is, "GAIN" = (Receiver's Transmit Output) minus (Receiver's Receive Input). See the examples below:

A. Remote modems designed for 0 dBm transmit and –16 dBm receive. G = 0 dBm – (-16) dBm = +16 dB. Switch +24 dB and –8 dB switches to "in".
B. Remote leased line interfaces with +7 dBm transmit and –16 dBm receive. G = 7 dBm – (-16) dBm = +23 dB. Switch = +24 and –1 dB switches to "in".
C. Local MUX interface to leased line with –16 dBm transmit and the +7 dBm receive. For this application, the MUX +7 transmit is connected to the 5493 receive line and the MUX receive line is connected to the 5493 transmit line. G = -16 dBm – +7 dBm = -23 dB. Switch –16 dB, -4 dB, -2 dB, and –1 dB switches to the "in" position. While the 2493 is in function 04, adjust R17 for a –16 dBm output level.

5.4 LEVEL: The tone output level may be adjusted by using the front panel accessible potentiometer (R17). This may be adjusted using an adjustment tool. It has no effect on loopback gain.

5.5 POWER: The Model 2493 DTMF Modem is normally installed in Tellabs or Wescom mounting facilities. It is available in 12, 24, and 48 VDC variations.

5.6 MODE DIPSWITCHES: The next area to program is the mode dipswitch, which are accessible through a window on the front panel. The table below is a summary of the dipswitch functions.

Dipswitch	Function	On (to left)	Open (to right)
1	Echo ASCII Input	No Echo	Echo after each DTMF out
2	Keyboard	Store & Forward	DTMF Keypad
3	No Function		
4	Radio/PSTN	K1 for PTT	K1 for Line Seize

Dipswitch 1 determines whether the ASCII input is echoed to the RS232 output during the DTMF tone output. The duration of the echo adds to the off time between DTMF tones. The echo takes 10/baud seconds per character – 133 mSec at 75 baud; 1 mSec at 9600 baud.

Dipswitch 2 operates the front panel keyboard. If it is set to the left the keyboard acts as a manual DTMF keyset. If to the right, keyboard entries cause the same function as a DTMF sequence.

5.7 PROGRAM WIRES: The brown, red, and orange program wires, located on the top right corner of the interface board, determine the baud rate, Interdigit timer, and the push-to-talk delay per the following table. If a character pin is already used and repeat digits are needed, use the associated repeat pin. Be careful when changing repeated wires.

Pin	**BROWN** **Baud Rate**	**RED** **Interdigit Timer** (seconds)	**ORANGE** **K1 Key-Up Delay** (seconds)	**YELLOW** DTMF ON (ms)	**GREEN** DTMF OFF (ms)	**BLUE** Reset Timer (seconds)
Post Name	**A1**	**A2**	**A3**	**A4**	**A5**	**AJ**
D	75	1.6	0.0	80	80	0.0
1	150	0.1	0.1	05	05	0.5
2	300	0.2	0.2	10	10	1.0
3	600	0.3	0.3	15	15	1.5
4	1200	0.4	0.4	20	20	2.0
5	2400	0.5	0.5	25	25	2.5
6	4800	0.6	0.6	30	30	3.0
7	9600	0.7	0.7	35	35	3.5
8	75	0.8	0.8	40	40	4.0
9	150	0.9	0.9	45	45	4.5
0	300	1.0	1.0	50	50	5.0
*	600	1.1	1.1	55	55	5.5
#	1200	1.2	1.2	60	60	6.0
A	2400	1.3	1.3	65	65	6.5
B	4800	1.4	1.4	70	70	7.0
C	9600	1.5	1.5	75	75	7.5

5.8 CONTROLLING 64 RELAYS FROM ONE MODEL 5493: The 5493 has the capability to control up to 64 external relays. The Model 5452 Relay Expander Card contains 8 relays. Up to 8, 5452 cards can be controlled by one 5493.

When using only one 5452 Relay Expander Card, a six digit DTMF string is used to control the external relays. The first three digits of the address of the card is **ABC**. The fourth digit is from the relay card you want to use (Use table below to set relay card number). A "*" in the fifth digit causes the corresponding relay to latch ON. A "#" in the fifth digit causes the corresponding relay to pulse ON, then latch OFF. A "A" in the fifth digit sets the corresponding relay to latch ON and the other 7 relays on the card to pulse ON, then latch OFF. The six digit determines the relay number on the card (1-8). This can also be "A" for all the relays on that card.

MODEM INTERNAL RELAY COMMANDS

ABCx*y sets one of the 64 relays.
ABCx#y reset one of the 64 relays.
ABCxAy sets relay y in-group x, resets the 7 in-group x.

The Yellow, Green, and Blue program wires on the Model 5452 Relay Expander Card determine the card number. The following table shows the programming sequence.

Relay Card No.	Yellow Wire	Green Wire	Blue Wire
1	0	2	3
2	0	4	5
3	0	6	7
4	8	0	1
5	8	2	3
6	8	4	5
7	8	6	7
8	0	0	1

5.11 LOOPBACK RECEIVER TEST FUNCTIONS: The 5493 modem works in conjunction with the Model 5212 and 2212 Loopback Receivers by using two different command formats. Internal commands (not DTMF transmitted) begin with a three-digit address followed by "A" and then a two-digit function code. Commands ABCA03, ABCA05, and ABCA09 cause the 2493 to send test tones according to the function code. ABCA0B causes measurements of inbound tones.

The 5493 control a remote 5212/2212 by sending DTMF commands. If the modem receives XXXX03, XXXX04, XXXX05, XXXX08, or XXXX09 it sends that DTMF and then measures any inbound tones. If it does not reach 2804 Hz, the modem will send XXXX00 to reset the remote. If the modem receives XXXX0B it sends that DTMF, then sends 404 to 2804 Hz at 0 dB, for the remote to measure. After 2804 Hz reading it measures the inbound noise level.

Listed below are the two digit function codes:

03: Generate a tone sequence from 404 to 2804 Hz (every 200 Hz except 2604) at "reference level" -- for inbound frequency response measurements.

04: Generate 1004 Hz, the "0 dB reference level" for mid-band loss.

05: Generate 1004 Hz at "reference level –13 dB" -- to detect compressions

08: Generate a tone sequence from 404 to 2804 Hz (every 200 except 2604) at "reference level – 13 dB" – to detect level compression versus frequency.

09: Generate 2804 Hz at "reference level" -- for high frequency loss.

0B: Causes the unit to measure outbound loss versus frequency.

5.12 AUTOANSWER/AUTODIALER: When current is detected through the ring detector the 5493 sends the ASCII message "RING" to the RS232 output. A relay command can be used to seize the phone line. The modem recognizes the comma (ASCII Hex) as a 2-second gap for dialing. ASCII, 9,1-(913)-841-7556 will cause the following dialing sequence: wait 2 seconds…. 9 …. Wait 2 seconds…. 19138417556.

5.13 SELECTIVE CALL: By using K1 as a radio push-to-talk relay, the 5493 can produce selective call tones. The tones can be either two tone sequential or four tone formats. When dipswitch 3 is to the left, the 5493 read inputs from a dry contact (between pins 45 and 53) as well as DTMF messages from a DTMF encoder.

DTMF TO TWO TONE SEQUENTIAL CONVERSION: The Model 5493 converts DTMF codes to a two-tone sequential format. The 1-Plus-1 format is compatible with Motorola Quik Call II and GE Type 99 frequencies and timing (see note). The blue program wire causes a delay (in 2.5-second increments) between the control and the PTT. "D" causes no delay; 1 through 9 represents 2.5 through 22.5 seconds of delay.

A four or five digit DTMF sequence causes a two-tone sequential, 1-Plus-1 selective call format. DTMF * in the first digit arms the function; digit 2 selects the group, digit 3 selects the first tone from that group, and digit 4 selects the second tone. For example *123 sends 368.5 Hz (Motorola group 1-tone 2), followed by 389.0 Hz. If digits 3 and 4 are equal, the "diagonal" tone substitutes for the first tone; for example. *611 selects 979.9 Hz followed by 1153.4 Hz.

A five-digit DTMF sequence will produce a two-tone sequential selective call with tones from different groups. DTMF * in the first digit arms the function; digits 2 and 3 select the first tone – 2 selects the group and 3 selects which tone; digits 4 and 5 select the second tone – 4 selects the group and 5 selects which tone. For example *1234 selects 368.5 Hz, followed by 313.0 Hz. The "diagonal" is not used with mixed groups.

GE Type 99 groups A, B, and C can be selected by DTMF 7, 8, and 9 as well as DTMF A, B, and C – either 8292 or B2C2 selects 787.5 Hz followed by 772.5. For keyboard control, using either a 4 or 5 digit DTMF code, omit the first digit "*" key.

The tone duration corresponds to the manufacturer's specifications and is summarized in the following table:

	First Tone	Gap	Second Tone
GE Type 99	1.00 Seconds	0.20 Seconds	1.50 Seconds
Motorola Quik Call II	1.25 Seconds	None	3.00 Seconds

Group Call: To make an 8.0 second 1+1 format group call, enter either "#" or "D" as the last digit; for example, *12# or #12D causes 8 seconds of 368.5 Hz.

Group select

DTMF	Group	Manufacturer
7	A	GE
8	B	GE
9	C	GE
A	A	GE
B	B	GE
C	C	GE
1	1	Motorola
2	2	Motorola
3	3	Motorola
4	4	Motorola
5	5	Motorola
6	6	Motorola
0	10	Motorola
*	11	Motorola

Tone select – For GE Type 99

DTMF	Group A	Group B	Group C
0	682.5	652.5	667.5
1	592.5	607.5	712.5
2	757.5	787.5	772.5
3	802.5	832.5	817.5
4	847.5	877.5	862.5
5	892.5	922.5	907.5
6	937.5	967.5	952.5
7	547.5	517.5	532.5
8	727.5	562.5	577.5
9	637.5	697.5	622.5
Diagonal	742.5	742.5	742.5

Tone select – For Motorola Quik Call II (1-PLUS-1)

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 10	Group 11
0	330.5	569.1	1092.4	321.7	553.9	1122.5	1472.9	19.0.2
1	349.0	600.9	288.5	339.6	584.8	1153.4	1513.5	1989.0
2	368.5	634.5	296.5	358.6	617.4	1185.2	1555.2	2043.8
3	389.0	669.9	304.7	378.6	651.9	1217.8	1598.0	2094.5
4	410.8	707.3	313.0	.99.8	688.3	1251.4	1642.0	2155.6
5	433.7	746.8	953.7	422.1	726.8	1285.8	1687.2	2212.2
6	457.9	788.5	979.9	445.7	767.4	1321.2	1733.7	2271.7
7	483.5	832.5	1006.9	470.5	810.2	1357.6	1781.5	2334.6
8	510.5	879.0	1034.7	496.8	855.5	1395.0	1830.5	2401.0
9	539.0	928.1	1063.2	524.6	903.2	1433.4	1881.0	2468.2
Diagonal	569.1	979.9	569.1	569.1	979.9	979.9	979.9	979.9

DTMF TO FOUR-TONE CONVERSION: The Model 5493 converts DTMF code to four tone formats. It is compatible with 2-Plus-2, Quik Call frequencies and timing (see note). The blue program wire causes a delay (in 2.5-second increments) between the control and the PTT. "D" causes no delay; 1 through 9 represents 2.5 through 22.5 seconds of delay. A six-digit DTMF string is used to select the various tones. See section 6.3 for tone selection.

A six-digit DTMF sequence causes a 2-PLUS-2 selective call format. DTMF * in digit 1 arms the function, digit 2 selects the group, digits 3 and 4 select the tones in the first pair, digits 5 and 6 select the tones in the second pair. Motorola Quik Call tones can be generated using DTMF 7, 8, and 9 as well as DTMF A, B, and C. For example **C**961 (or *9*961) selects 977.2 and 794.3 Hz followed by 582.1 and 346.7 Hz. For keyboard control, omit the first digit "*" key.

Digit 2 DTMF A selects group A, B selects B, C selects Z.
Digit 2 DTMF 7 selects group A, 8 selects B, 9 selects Z.

DTMF digits 3, 4, 5, 6 – tone select – Motorola Quik Call

DTMF	1	2	3	4	5	6	7	8	9	0	*	#
Group	C	D	E	F	G	H	J	K	L	M	N	P
A	358.9	398.1	441.6	489.8	543.3	602.6	668.3	741.3	822.2	912.0	1011.6	1122.1
B	371.5	412.1	457.1	507.0	562.3	623.7	691.8	767.4	851.1	944.1	1047.1	1161.4
Z	346.7	384.6	426.6	473.2	524.8	582.1	645.7	716.7	794.3	881.0	977.2	1084.0

NOTE: 1-Plus-1 and 2-Plus-2 are registered trademarks of Bramco, Inc. Type 99 is a registered trademark of General Electric Company. Quik Call and Quik Call II are registered trademarks of Motorola, Inc.

6. TESTING

6.1 The following equipment is required to perform some of the following test procedures.

1. Oscilloscope with a 1 Megohm or higher impedance.
2. Multimeter with 10 Megohm impedance. A multimeter with a 20 Kohm per volt impedance may be substituted but resulting readings may be lower.
3. DTMF Encoder or tone telephone.
4. Audio amplifier.

6.2 Connect a simple audio amplifier to the transmit output terminals, (card edge fingers 1 and 5), with all dipswitches to the left, press front panel keyboard switch 2 and verify that the mode LED displays “2”. Relay K1 should operate and a brief DTMF identification sequence should be sent corresponding to the programmed address. Hold keyboard switch 2 in for several seconds. The DTMF identification sequence should repeat about once every two seconds.

6.3 If these functions occur, virtually the entire unit has been verified. Integrated circuits U101 – U109 and U5 – U7 are all functioning properly. The only significant circuits not yet verified are the DTMF receiver chips U1-4 and the regulator U8.

6.4 If this sequence does not occur, check for proper functioning of U8, which is a NEGATIVE 5-volt DC regulator. U8 provides the “derived ground” for the microprocessor and the “analog ground” for the audio circuits.

6.5 Continue the test and verification sequence by pushing the different function keys on the keyboard to put the DTMF Modem into each of it’s various modes.

6.6 To verify DTMF receiver operation, connect a DTMF generator to the receive input terminals (card edge 22 and 25 will work for all configurations). With all dipswitches to the _____, observe the LED display following DTMF inputs 0 – 9. Push the keyboard front panel switch 7. Dial a DTMF 4 on the DTMF generator. The LED display should indicate 4, and you should hear the 1004 Hz tone.

6.7 To check the companion 5452 Relay Expander card in radio linked systems send the following sequence: 1591*1, 1591*2, 1591*3,….., 1591*8. All LED’s should now be on. Send 1591#1, 1591#2, 1591#3,….., 1591#8. All LED’s should now be off. 1591*A will turn on relays 1 through 8, 1591#A will pulse them all off.

7. SPECIFICATION

7.1 GENERAL SPECIFICATIONS CONTROLS & INDICATORS: 12 button keypad for local mode select with numerical LED display to indicate selection. Two dipswitches select features.

POWER SUPPLY: 24VDC

5493	DC Voltage	Current Drain: Idle	Activated
-0XXX2	(21 to 28)	100 mA	175 mA

Additional current due to each 5452 Relay expansion card (if used).

	24 VDC
LED annunciator power Switch On	+13 mA
LED annunciator power Switch Off	+1 mA

TEMPERATURE RANGE: -30°C TO +70°C operating; -55°C to +85°C storage

DIMENTIONS: Height 5.58" (14.17 cM); Width 1.42" (3.61 cM); depth 5.53" (14.00 Cm)

CONTROL & ID TONE FORMAT: DTMF 2 of 8

DTMF Character	Low Tone (Hz)	High Tone (Hz)	Decoder Hex Code
1	697	1209	1
2	697	1336	2
3	697	1477	3
DTMF Character	Low Tone (Hz)	High Tone (Hz)	Decoder Hex Code
4	770	1209	4
5	770	1336	5
6	770	1477	6
7	852	1209	7
8	852	1336	8
9	852	1477	9
0	941	1336	A
*	941	1209	B
#	941	1477	C
A	697	1633	D
B	770	1633	E
C	852	1633	F
D	941	1633	0

ADDRESS CODING: up to 4 digits, field programmable.

SIGNALING SPEED: Each character must be minimum 40 ms in duration; with a maximum of 2.4 seconds between characters.

7.2 ENCODER SPEDIFICATIONS

OUTPUT IMPEDANCE: In normal mode, the customer's equipment – connected between pins 11 and 15 – terminates the line at pins 9 and 13. During test modes, the 5493 are 600 or 900 ohms – balanced and transformer isolated.

FREQUENCY ACCURACY: 1004 Hz test tone of all units: +0-2 Hz, phase continuous step tones of –0XXXX and –1XXXX 300, 500,…, 2900 Hz: +0-0.2% step tones of –2XXXX 404, 604, …, 2804 Hz: ±0.02% DTMF of –0XXXX and –1XXXX: ±0.8% DTMF of –2XXXX: ±0.02%

ENCODER DISTORTION: Distortion (function 04): 0.5% maximum THD.
Distortion other modes: 1% maximum THD.

TONE OUTPUT LEVEL: R17 is accessible through the front panel and adjusts the 1004 Hz (function 04) tone output level from –16 to +7 dBm into 600 ohms (0.35 to 4.9 VPP, and 0.12 to 1.7 VRMS composite – the same voltage into 900 Ohms). The output level of all other functions refers to "0 dB Reference."

DTMF ID OUTPUT LEVEL: peak to peak amplitude equal to a 0 dB reference tone.

DTMF Tone Twist +0.2 dB maximum difference between low and high tone. Stepped Sweep (function 03) output level: 0 dB reference +0.25 dB.

SWEEP (functions 03 and 08): Sweep rate for –0XXXX and –1XXXX: 300, 500,…. Each tone present for 5 seconds with a 1-second pause between tones. Sequence takes about 90 seconds. Sweep rate for –2XXXX: 404, 606,…. Each tone present for 1.5 seconds with a 1-second pause between tones. Sequence takes about 30 seconds.

High Tone (function 09): 2804 Hz (2700, 2900) @ 0 dB reference ±0.2 dB.

Function 05 is the same as 04, but @ 0 dB reference –13 ±0.2 dB.

Function 08 is the same sequence as 03, but @ 0 dB reference –13 ±0.2 dB.

7.3 DECODER SPECIFICATIONS

INPUT TONE LEVEL RANGE: 0.02 to 2.0 VRMS, each DTMF component tone (NOT composite level). If DTMF components are equal, this corresponds to a composite signal from 0.0283 to 2.83 VRMS, 0.113 to 11.3 VPP, and –28.75 to +11.25 dBm. With 15 dB twist, the composite signal is 0.375 to 6.66 VPP.

INPUT IMPEDANCE: When in normal mode, the DTMF receiver provides 5 Kohm, in parallel with the customer's equipment – connected between pins 18 and 19 – to terminate the line at pins 21 and 27. During test modes: 600 or 900 ohms – Balanced and transformer isolated.

CTCSS REJECTION: The decoding process will not be inhibited by any tone from 67 to 40 Hz and no more than 6 dB above the weaker DTMF component tone.

SINAD: 16 dB or better signal.

TONE TWIST TOLERANCE: Accepts +15 dB tone twist. Each DTMF component must be within +1.8% of nominal frequency and from 0.02 to 2.0 VRMS.

SIGNALING SPEED: Each character 40 milliseconds minimum on and off times.

INTERDIGIT TIMING: 2.4 seconds.

CONTROL MODE (*9 Set/#9 Reset) RELAY OUTPUT: K2 – 2 form-C contacts, rated 2 amps 30 VDC, or 0.6 amps at 120 VDC.

8. Options: When ordering, please specify power supply option. The part-number/suffix label for the 5493 is located on the bottom of the unit. Refer to the chart below for suffix explanation.

Model Number 5493 – 5 0 0 0 X

	2	24 VDC

9. Warranty: The equipment herein described is warranted for a period of one year from date of shipment. Signalcrafters, Inc. will repair or replace any unit, which fails during this period due to defective material or workmanship. Unless specifically authorized by Signalcrafters, all in-warranty repairs must be made at the factory.

10. CIRCUIT DESCRIPTION

10.1 The Model 5493 DTMF Modem is divided into four printed circuit boards. The top board contains the microprocessor; the bottom board contains the input/output circuitry including the DTMF receiver, output amplifier, relays, and regulator. The measurement board and the isolator board are located in-between the two main boards. The following information describes the DTMF Tone Interface Board, circuit D17555 (bottom board).

10.2 POWER SUPPLY: 5-volt power is provided by U8, a NEGATIVE 5-volt regulator. The digital circuitry is powered by U8. The analog circuitry uses the –5 volt output of U8 as an "analog ground"; the + common is the analog positive supply; and the –12 volt (input or regulator U9's output) is the analog negative supply.

10.3 DTMF RECEIVER: The 3.58 MHz clock on the microprocessor board feeds U1/15. U1/14 in turn feeds U2/2. U1/5 provides a pseudo-ground reference voltage, which is buffered by U3b for U3 and U4. The received DTMF tone comes through a program wire, either from external

input (pin 14), or from the receive line through T1 and U6b to U1, a DTMF band splitter and dial tone reject filter. The DTMF high tone component from U1/11 is amplified by U3c and wave-shaped by U4b before being applied to the DTMF Decoder U2/4. The DTMF low tone component from U1/2 is amplified by U3a and wave-shaped by U4a before being applied to the DTMF Decoder U2/13. The output from U2 is a hexadecimal representation of the DTMF input as follows:

DTMF	U2 Pin Number				DTMF	U2 Pin Number			
Character	8	7	6	5	Character	8	7	6	5
1	0	0	0	1	9	1	0	0	1
2	0	0	1	0	0	1	0	1	0
3	0	0	1	1	*	1	0	1	1
4	0	1	0	0	#	1	1	0	0
5	0	1	0	1	A	1	1	0	1
6	0	1	1	0	B	1	1	1	0
7	0	1	1	1	C	1	1	1	1
8	1	0	0	0	D	0	0	0	0

10.4 Address Program Wire/Dipswitch selector: The microprocessor selects 8 different inputs to U102 via U5. A 4028 is used as a 1 of 8 selector. The microprocessor causes U5 to select either the DTMF receiver, the address program wires, or the program mode dipswitches according to this table:

U102B output			U102B input
PB6	PB5	PB4	PB7, PB3, PB2, PB1, PB0
0	0	0	DTMF Receiver
0	0	1	Address 1
0	1	0	Address 2
0	1	1	Address 3
1	0	0	Address 4
1	0	1	Timor Duration
1	1	0	Joker Digit
1	1	1	Dipswitches SW1-1, to SW1-4

10.5 TRANSMIT OUTPUT: The microprocessor uses Q1 to select either a loopback signal through U7a or the microprocessor generated tone through U7c. U6d is an analog inverter of U6c. U6c and U6d drive transformer T2 in push-pull fashion to produce a low distortion output, which is impedance selected by the “ZE” program wire to either 600 or 900 ohms.

10.6 ATTENUATOR/GAIN SWITCHES: R20 through R30 and SW2-1 through SW3-2 are precision 1, 2, 4, 8, and 16 dB attenuates. R31, R32, and SW3-3 coupled with U7b are a precision 0 or +24 dB feedback path around U6c.

10.7 SYNTHESIZER FILTER: R19, C10-12 and T3 are a low pass filter (with poles and one zero) designed to remove the upper frequency components of the synthesized tones.

10.8 Relays K1 and K2 are controlled by the microprocessor on the top board. Relay K1 is “set” by all test modes (NOT relay control), and “reset” by return to normal. K2 either follows

K1, or is a semi-independent remote control relay. For the various K2 operations, refer to 7.15 and 7.16.

NOTE: The following information describes the microprocessor board circuit D18280-10001 (top board).

10.9 The top board contains the microprocessor unit (MPU) U101; the peripheral interface adapters (PIA) U102, U103; the programmable read only memory (PROM) U104; the crystal oscillator, U105; the watchdog timer, U106; power clear comparator, U107; D/A converter U108; and the seven segment LED drivers, U109.

10.10 CRYSTAL OSCILLATOR: Y101, U105a, along with R123, R124, C109, and C110 are a 3.58 MHz crystal clock oscillator. U105b distributes the clock to the top board, and U105c to the bottom board.

10.11 PERIPHERAL INTERFACE ADAPTERS: U102 interfaces the MPU to the keyboard contacts, Q1, DTMF receiver, address program wires, program dipswitches, and watchdog timer. U103 interfaces the MPU to the D/A converter, tone generator, relays and LED display driver.

10.12 WATCHDOG TIMER/POWER CLEAR: U107 provides a power clear reset when power is applied and when negative transient power supply spikes occur. U106 monitors pin 39 of U102. If there is more than one second between triggers of U106b, a 10-millisecond power on clear is provided to the microprocessor via CR101.

10.13 MICROPROCESSOR: U101 is the MPU, which controls the operation of the DTMF Modem. It reads commands from the PROM (U104) and issues corresponding controls to P1A (U102) and PIA (U103) to do input/output functions.

Note: The following information describes the measurement board circuit.

10.14 Input level and frequency measurement is made by adjusting the gain of U5 until the combined gain of U5 and U6 causes the input tone to produce a square-wave into the microprocessor PB13.

10.15 There are 2 resistor ladders, which set the circuit gain. R12 through R16 and R22 form five 1-dB attenuators. R18 through R21 form seven 6-dB attenuators. Since they are connected in the negative feedback path, they cause U5 to have a corresponding gain. To select a gain, the microprocessor pulses U40's clock until it selects ONE loss attenuator lead to be connected to U5/pin 3 – and ONE gain attenuator lead to be connected to U5/pin 2.

10.16 To measure the input frequency, the microprocessor chooses a high gain and counts the half cycles for 500 milliseconds.

10.17 The gain of the circuit is determined by adding Gain components.

Q1	-0	Q8	+6
Q2	-1	Q9	+12
Q3	-1	Q10	+18
Q4	-3	Q11	+24
Q5	-4	Q12	+30
Q6	-5	Q13	+36
Q7	+0	Q14	+42

10.18 Practical op-amp gain limits cause the level readings to be weaker than actual, for tones weaker than –30 dB.

10.19 To measure the input level, the microprocessor chooses 0 dB gain (Q1 and Q7), and checks for presence of input from PB13. If it does not see a resulting signal, it increases the gain by 6 dB unit it sees a result.

It then decreases the gain 1 dB at a time (adding 99) until the response disappears – but only up to 5 dB removed. This input measurement process is repeated until it gets 2 out of 3 equal readings – or there is no measurable input for more than 2.5 seconds.

10.20 During calibration, R8 is adjusted so that at 1004 Hz:

-15.5 dBm tone causes a 15DB or 16DB reading
-16.0 dBm tone causes a 16DB reading
-16.5 dBm tone causes a 16DB or 17DB reading

11. ACCESSORY ITEMS:

The following accessories are available for the 5493:

Relay Expander Card: The Model 5452 Relay Expander card is controlled by the Model 5493 microprocessor card. The Relay Expander is “addressable” – Up to 8 Relay Cards may be driven by one 5493.

Model 5452 Relay Expander Card 8 x 1 form – C with LED annunciator.

APPENDIX A

FOUR-WIRE Applications

Terminal Number	CONNECTION	Terminal Number	CONNECTION
1	Tone out, un-switched		
3	Auxiliary transmit capacitor	4	(shorted to 3)
5	Auxiliary transmit capacitor	6	(shorted to 5)
7	Tone out, un-switched		
9	Transmit out ring		
11	Transmit in ring		
13	Transmit out tip	14	Externam DTMF input **
15	Transmit in tip		
17	Common Power IN	18	Receive out tip
19	Receive out ring		
21	Receive in tip (shorted to 22)	22	Receive in tip
23	Auxiliary receive capacitor	24	(shorted to 23)
25	Auxiliary receive capacitor	26	(shorted to 25)
27	Receive in ring (shorted to 28)	28	Receive in ring
29	K2 common		
31	K2 normally closed		
33	K2 normally open		
35	-24VDC Power IN	36	+ Battery
37	K2 normally closed – switched to +		
39	K2 normally open -- switched to +		
41	+ source for relay/41 for 12 VDC units		
43	- source for relay/43 for 12 VDC units		
45	- 5 VDC output; to relay/45		
47		48	
49		50	
51			
53	To relay/53		
55	To relay/55		

TWO-WIRE Applications

Terminal Number	CONNECTION	Terminal Number	CONNECTION
1	To 23		
3	Auxiliary capacitor	4	(shorted to 3)
5	Line buildout (Phantom)	6	(shorted to 5)
7	Line ring		
9	To 7		
11	Load ring		
13		14	10 ohm resistor to 4
15			
17	Common Power IN	18	Load tip
19			
21	Line tip	22	Line tip
23	To 1	24	(shorted to 23)
25	Auxiliary capacitor	26	(shorted to 25)
27	To 25	28	Line buildout
29	K2 common		
31	K2 normally closed		
33	K2 normally open		
35	-24VDC Power IN	36	+ Battery
37	K2 normally closed – switched to +		
39	K2 normally open -- switched to +		
41	+ source for relay/41 for 12 VDC units		
43	- source for relay/43 for 12 VDC units		
45	- 5 VDC output; to relay/45		
47		48	
49		50	
51			
53	To relay/53		
55	To relay/55		