Telos 100

Digital Hybrid Telephone Interface

User's Manual

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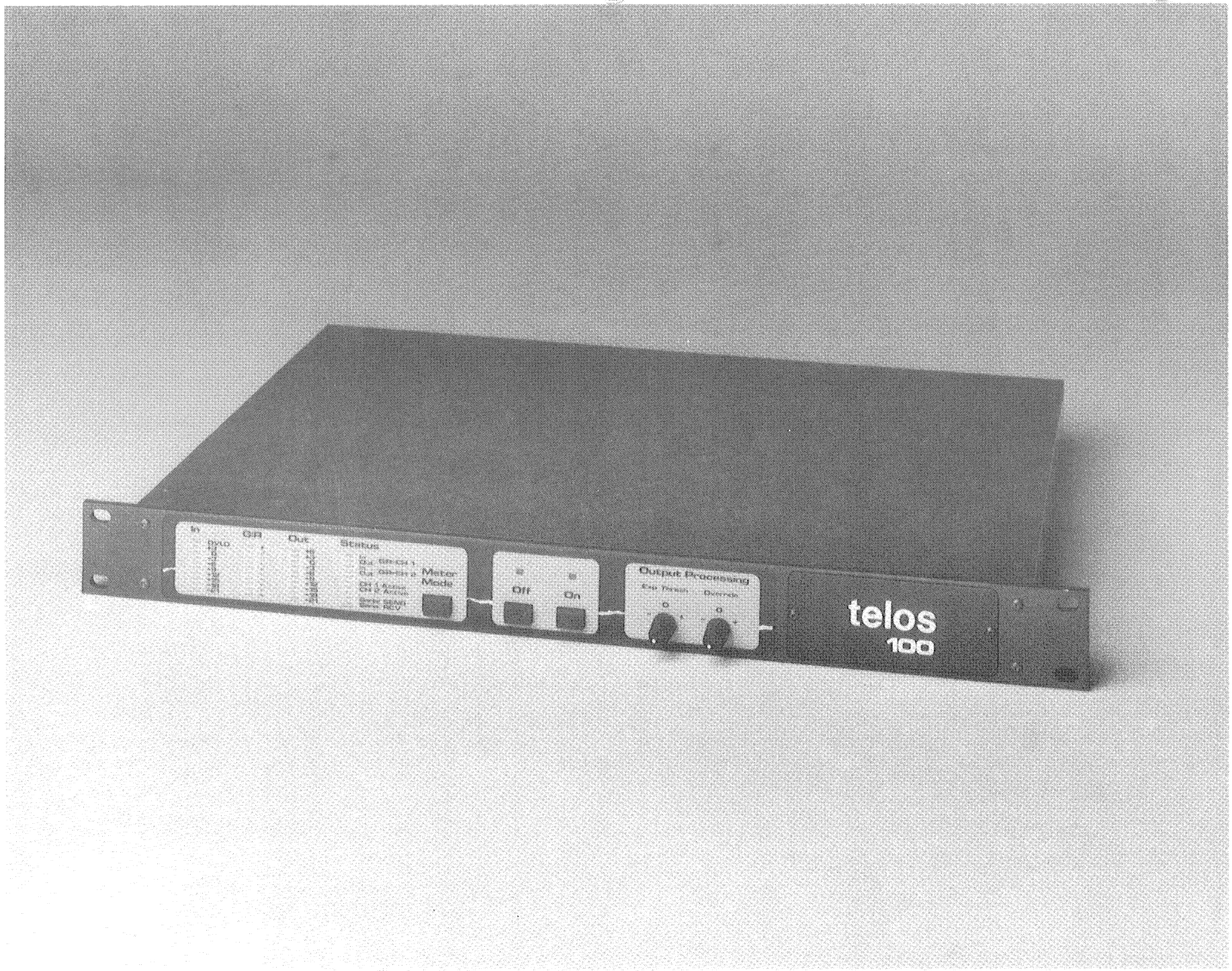
telos systems


Meter Mode
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telos
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telos systems
TLS CORPORATION
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CLEVELAND, OHIO 44114
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May 26, 1989

Special Note Regarding This Manual and Your Unit ...

One of the many advantages of digital signal processing is that impoved technology can be incorporated into existing hardware by merely changing the software contained in EPROM IC's. This is possible because the software nearly completely determines the system operating characteristics. The Telos 100 hybrid in this carton has version 6.0 software which implements a number of advances over earlier software versions.

However, technology continues to march on!

This manual refers to an "acoustic ducker" function. The software which provides this important new feature is currently in "beta test." That is, we have it in use in a few cooperative stations who will report any bugs and/or suggestions for further enhancement to us. When the beta test process is complete in approximately 30 days, we will make this new software (version 7.0) available to existing Telos owners.

If you would like a free upgrade, please contact us in about a month - or make a notation on the warranty form indicating that you would like the upgrade when available. The upgrade process consists of swapping two IC's which are in sockets on the main PC board.

Incidentally, we really do suggest that you return the warranty form. We're being honest when we say that we'll keep you posted on upgrades, etc.

March 29, 1988

A personal note:

The Telos 100 is the product I always wished to have for myself. In my own work as a Chief Engineer and talk show host, I had often encountered the familiar problems with speakerphones and hybrids. Starting about 15 years ago at my first station, I had been tinkering with telephone systems. The available equipment wasn't very good, but a better solution proved elusive - until digital signal processing technology came on to the scene a few years ago.

I knew then that the possibility for vast improvement in hybrid performance had finally arrived. As you might know, this led to the Telos 10 - one of the first broadcast products to incorporate the new technology. As many users will tell you, it was the first phone interface that really worked! Somewhat to my surprise, the10 became a commercial success, with over 300 of them now in daily use. The users list reads like a "who's who" among great radio stations and networks.

We're proud, now, to introduce the second generation Telos 100. It uses the latest in digital processing technology to produce truly superb performance. In addition, we've incorporated the considerable "real-world" knowledge gained from four years of Telos 10 field experience.

No longer a "garage" outfit, Telos Systems is now a "bona-fide" company with a phone and an office and a staff and everything! If you need to contact us for any reason, it's:

Telos Systems
1729 Superior Avenue, Third Floor North
Cleveland, Ohio 44114
(216) 241-7225.

I welcome questions, suggestions and comments any time.

Of course, the Telos dealer network is also ready to assist. They usually know what plug goes where and can answer many questions.

Keep on keeping the GM happy...

Steve Church

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SECTION 1 - INTRODUCTION

1.0 INTRODUCTION

The Telos 100 Hybrid

The Telos 100 hybrid is a second generation digital signal processing-based telephone interface. The unit uses the latest, most powerful signal processing IC's and carefully crafted software for very high performance.

It is a single-line device suitable for stand-alone use where access to a single phone line is desired. In this application, a loop-through jack is provided for a desk phone. An auto-answer plug-on board is available.

Telephone connections are via standard modular jack, while audio input and output are connected at XLR's. One balanced input and two balanced outputs are provided.

Purpose

The purpose of the Telos 100 broadcast telephone hybrid is to deliver to the console "pure" caller audio with as little of the send (announcer) audio as possible mixed in. Until digital signal processing techniques were applied to the telephone interface problem, there were two choices:

1. **Switching.** The send and receive paths were separated by having only one talk direction active at a time. The common "speakerphones" use this approach. The disadvantage is that natural conversation is impossible, since the caller is cut-off when the announcer talks - and vice-versa.

2. **Analog hybrids.** These were, on most phone lines, *very* poor at removing the send signal from the caller's audio. This meant that the announcer's voice would become distorted as the phone audio was added to the mix.

(A full discussion of hybrids and interface systems is included in the *Telos Telephone Q & A* which is part of this manual.)

The Telos 100 uses state-of-the-art digital techniques to perform the hybrid function - the subtraction of the send from the receive audio. The input and caller audio signals are converted to digital and operated on in such a way as to very effectively remove the announcer audio from the output while maintaining natural simultaneous full-duplex conversation. The digital approach assures consistently good trans-hybrid loss regardless of varying phone line impedance.

Special Features

The Telos 100 incorporates sophisticated audio processing *in the digital domain* for gain control and filtering. A digital high-pass filter is used to reduce hum and other low frequency interference. High frequency noise above the telephone frequency range is also attenuated.

Smart Digital Automatic Gain control smooths input and output levels. A noise-gate/downward expander is provided on the receive path to reduce phone line noise during caller pauses.

An adjustable "override" function is provided to allow ducking of the caller while the announcer is speaking.

Front panel metering is provided for input level, output level, and gain reduction. Two front panel pots control the output expander threshold and the amount of override ducking. An access panel covers trimmers for input and output level adjust and coarse null. A dip switch under the access cover is used for mode setting.

Operation

When a call is initially established, a brief mute/adapt period provides an opportunity for the system to set up to the line before the call goes on the air. The caller hears a "noisy tone, " but none of this tone makes it on the air since the output is muted during this time. This has the incidental benefit of removing the line switching "clunk."

Adaption continues as the conversation proceeds, using voice as the driving signal.

The Hardware

The process of Analog-to-Digital and Digital-to-Analog conversion is critical to audio quality and hybrid performance. In the Telos 100, the A-to-D converters use a unique approach called "delta-sigma-conversion" to generate a full 16 bits of resolution at very low noise and distortion. These converters sample the signal at a 2 MHz rate and digitally filter to the system's 16 KHz system sampling rate.

The D-to-A converter is the famous Burr-Brown PCM53, a part used in many CD players and other high quality digital audio systems.

As in state-of-the-art compact disk players, a 2X-oversampling scheme is used to reduce analog filter complexity and provide highest fidelity.

Because the audio processing functions are performed in the digital domain, the hardware design of the Telos 100 is quite simple.

Multi-Line Systems

For multi-line systems, the unit may be interfaced to a standard "1A2" key system by using add on modules made by Telos Systems. In addition, direct interface to multiple central office lines may be accomplished with our new "Direct Interface Module." Since the Telos 100 system is modular, many configurations are possible to implement the desired number of lines and hybrids.

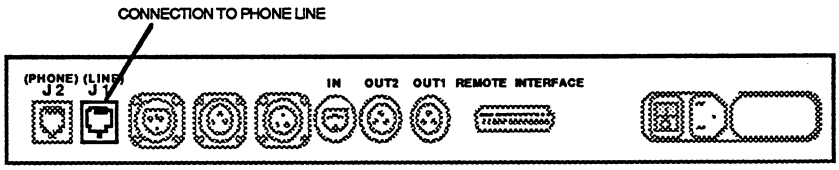
User implemented schemes are possible which would allow connection to some "electronic" phone systems.

SECTION 2 - INSTALLATION

2.1 CONNECTION TO THE TELEPHONE LINE

Simple Single-Line Installation

Phone line connection is made via a standard modular jack on the rear panel (labelled J1).



Back panel view of hybrid showing location of phone line connector.

J1 should be connected to the incoming central office telephone line using a modular cord (provided).

J2 is a loop-through connection which passes the phone line through when the hybrid is not active. It is normally used for connection of a desk set phone.

Both modular jacks use the center two pins (Red & Green) for the audio connection.

"A lead" Output

The "A lead" output provides a relay contact closure which may be used for any desired purpose. Typical application would be to hold up the line when user-devised connection schemes to multi-line phones are implemented.

The outer two pins (Black & Yellow) of both J1 and J2 provide the A lead output.

Auto-answer capability

Telos manufactures a plug-on PC board which may be installed inside the hybrid to provide this function. With this card, the hybrid will

automatically switch on when a line rings in and will switch off when a loop current drop is detected. The auto-answer card is available from any dealer or direct for $50.

Multi-line Installation with Telos Interface Modules

Information on use of Telos' multi-line control and interface modules is given in the manual for the appropriate modules. Telos manufactures a full line of line selection, interface, and control equipment. We have interface modules for connection to 1A2 key equipment, as well as for direct connection to telephone lines. Control surface options include table-top consoles and drop-in modules for the PR&E consoles.

"1A2" Key System Installation Without the Telos Modules

It is possible to connect the Telos 100 hybrid to "1A2" key phones without the Telos interface module. With this approach, the key phone is used as the line select device. An application note is available from us, if you wish to construct this kind of system.

The scheme is fairly involved because the "1A2" A leads must be sensed and turned into pulses which turn the hybrid on and off and provide a trigger for the mute/null mode upon selection of a new line.

The section on key systems in the Telephone Q & A section of this manual may be helpful if you desire to construct your own interface.

Electronic Phone Systems

Most electronic phone systems use an analog talk path. This means that the hybrid can be connected to the system by inserting it in the analog path by breaking the connection from the phone switching equipment to the instrument. Usually, the talk audio is available on the center two wires of the line going to the phone. Looping this through the hybrid gets the audio connected.

The operator is responsible for turning the hybrid on and off upon initiation of each call. The hybrid's on and off remote may be connected to the

console's on/off logic outputs to perform this function. This scheme works well for one-call-at-a-time situations as you would have in a newsroom or production studio or for occasional on-air use.

A problem remains, however, when calls need to be taken one after the other, as in a talk show situation. In most cases, the hybrid must be told when a new line is selected so that adaption to the line can occur. It may be possible to derive an appropriate pulse from the phone by "tacking-on" an external circuit of some kind which would trigger the hybrid's remote on/off function. Remember too, the hybrid should be switched off or its input audio removed when no line is active. Otherwise, the hybrid will proceed to adjust itself to the high impedance presented to it and may take a few seconds to recover from this condition when a call is subsequently taken. Your kindly phone supplier may be able to help. If you have any luck along these lines, please let us know so that we can produce an application note for other users.

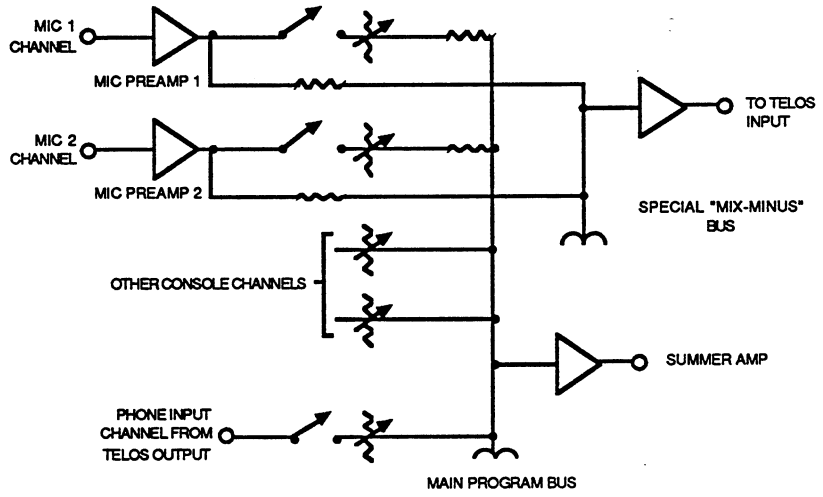
With phone systems that have a digital talk path, the situation of the on/off control is as above with the additional complication that you need to find a way to get at the converted-to-analog signal inside the phone set. Perhaps some poking around with a scope or headphones may be useful in this endeavor. Again, maybe your phone provider company might help. Please let us know what you find!

The *Telos Telephone Q & A* has more information on electronic phone systems.

2.2 AUDIO

2.2.1 Mix-Minus

The Telos 100 input should be fed "mix-minus" audio. That is, the mix of all the sources you want to feed the phone minus the hybrid output itself.



Mix-Minus Block Diagram.

Broadcast Consoles

Most modern broadcast consoles make some provision for mix-minus.

In the Harrison consoles, for instance, the "clean-feed" bus is perfect since each module can be selectively switched in and out of the hybrid send. This is useful since you sometimes want only one mic feeding the phone, sometimes you want three or four mics (during the morning show, for instance), and sometimes you want to feed cart machines when callers need to hear and react to contest effects, etc.

As for other popular consoles, the Pacific Recorders family have busses which can be used for hybrid feed and a special module for this purpose.

The Auditronics consoles have an awkward arrangement that is best avoided or bypassed. Their TEL module wasn't well conceived.

User-Provided Mix-Minus

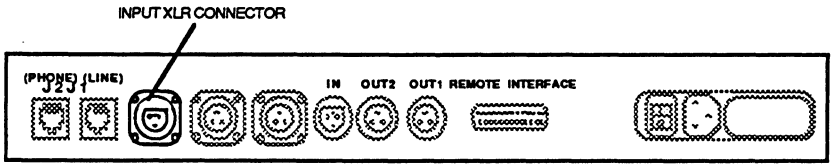
A lot of people just take the patch send or pre-amp output from the mic channel to feed the phone. This works well, but doesn't have much flexibility. One approach which allows more control is to use an outboard mixer to combine sources as desired. All of the desired sources are paralleled into the on-air board and the mixer, with the mixer's output feeding the hybrid.

A Good Idea...

Here's a neat scheme for stations which do a lot of taping of calls for later play on the air. The mix-minus goes into the left channel of the studio tape machine, while the right channel gets fed from the hybrid output. The result is a two-track tape with the announcer and caller audio separated. When you play back on the air, you set the console input to mono and adjust the relative balance as desired. You also have a tape which is easier to do production from for contest squeals, etc.

2.2.2 Input Connection

The input is of the common active balanced variety. It uses the rear panel XLR. Input levels of approximately -10 to +8 dBm are accommodated. Pin 1 is ground, and pins 2 & 3 are the balanced audio inputs.

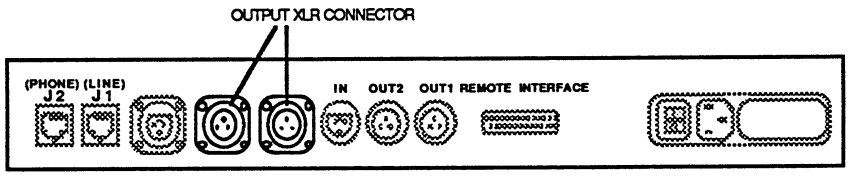


Back panel view of hybrid showing location of audio input connector.

Unbalanced sources may be used by tieing pins 1 & 2 together and connecting to the source ground while applying the signal hot to pin 3.

2.2.3 Output Connections

There are two separate and independent active differential audio outputs. Both are via rear panel male XLR connectors.



Back panel view of hybrid showing location of audio output connectors.

Pin 1 is ground; pins 2 and 3 are the signal outputs.

If an unbalanced output is required, connect between ground and either of the hot pins. Do not ground the unused hot pin.

The output level, when taken balanced, is approximately 0 dBm into a high impedance load when the output trimmer is adjusted for a normal reading on the LED meter. The level will be a few dB lower into 600 Ω due to an internal 100 Ω resistor on each output side. Of course, the level, when taken unbalanced, will be 6 dB lower.

2.3 CONTROL

A female DB25-type connector on the rear panel provides access to control functions. In addition, parallel telephone connections are provided. The pin numbers for each function are given in the following table.

REMOTE CONNECTOR P1 PIN-OUT

Function	Pin #
Ground	7, 19, 20
OFF (momentary closure to ground required)	11
ON (momentary closure to ground required)	12
Parallel of J1 modular phone jack	13, 25
"A lead" relay closure (parallels J2 in mode 2)	23, 24
Serial SEND*	3
Serial RECEIVE*	2
Serial +9 VDC*	5, 6, 8

* Only present on serial control versions

Remote OFF/ON

OFF and ON control requires a momentary closure to ground. It is a standard TTL input pulled-up with a 2.2 KΩ resistor. Thus, it may be connected directly to switches or may be driven by an open collector or TTL-compatible logic output as desired.

Serial Remote Control

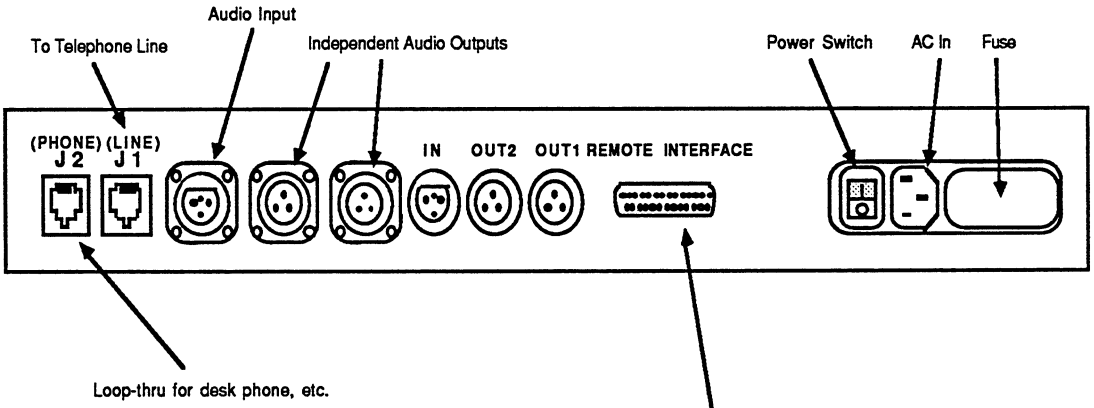
The serial connections are not active on hybrids intended for stand-alone or simple multi-line operation. The serial I/O channel may be used for RS-232 control in large systems with multiple hybrids, where on/off control is via a serial bus.

Telephone Line Connections via the DB25 Connector

Phone connector J1 is paralleled to pins 13 and 25. These may be used instead of the modular connector if desired.

"A" control is provided on pins 23 and 24. "A" control is phone terminology for a simple relay closure which is active when a line is on. It may be used to control phone equipment or as a way to operate a remote indicator.

2.4 BACK PANEL CONNECTORS & FUNCTIONS SUMMARY



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Serial +9 VDC*	5, 6, 8

* Only present on serial control versions

SECTION 3 - OPERATION

3.1 FRONT PANEL CONTROLS

ON/OFF Pushbuttons

When the ON button is pressed, the phone line is seized and the system sends a burst of white noise down the line to cause adaption to be accomplished prior to the conversation start. During this time, the outputs are muted.

At the conclusion of the mute/adapt period, the output is enabled and the conversation may proceed.

When the OFF button is pressed, the phone line is released.

Expansion Threshold

This adjustment determines the "knee" for the output expansion function.

When fully counter-clockwise, the expansion begins to "open up" at around a -40 dBm caller level; when fully clockwise, the level required is about -10 dBm.

Thus, for weaker calls, this control should be set more counter-clockwise. When line levels are generally good and you wish maximum noise-reduction effectiveness, this control should be set more clockwise.

Residual hybrid leakage is also reduced by the expand function, since leakage is usually below the threshold when this control is set to higher (more clockwise) values.

You'll have to experiment with this control to find the best compromise for your particular situation.

Override

This controls the amount of "caller ducking" when send audio is present.

There is approximately 6 dB of ducking when the control is set to mid-position. At this setting, very little noticeable change in caller level will be noticed due to the relatively fast time constant used and the masking provided by the presence of the send audio.

The purpose of this function is twofold:

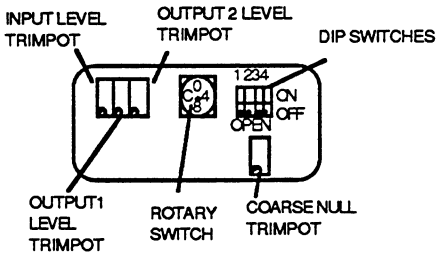
1. **Aesthetic.** Some air talents prefer the effect of having control over the caller when they speak.

2. **Improvement of "dynamic" Trans-hybrid Loss.** Advancing this control reduces leakage at the expense of full simultaneous conversation. In effect, the system becomes more "speaker-phone-like." Despite the very good trans-hybrid loss provided by the Telos 100, some poorer phone lines may require you to use a fair amount of override.

3.2 ACCESS PANEL CONTROLS

Description

The access panel controls permit "fine tuning" the Telos 100 hybrid for the installation at hand. The diagram below shows the function of each control.



Access panel controls.

Input Level Trimpot

This trimpot adjusts the input level. Simply adjust for a normal reading on the input LED meter.

Output Level Trimpot

There are two output level trimpots, one for each of the independent outputs. Adjust each for the desired level. The LED output level meter is located in the circuit after these controls and is calibrated so that the output is approximately 0 dB into a high impedance load at full-scale.

DIP Switches

Switch 1: course null mode enable. This switch is used when performing the coarse null adjustment, as explained in the description of the Null Trimpot. The noise generator is turned on and the digital adaptive hybrid and processing sections are bypassed.

Switch 2: tone burst disable. When this switch is on, the noise burst at turn-on is disabled. Normally, with this switch off, whenever the ON button of the Telos 100 is pressed (or remotely set), the output of the hybrid is muted and a burst of white noise is sent down the phone line. This causes the hybrid to adapt to each new call for optimal nulling before the conversation proceeds. The Telos 100 will continue to adapt on the send audio (announcer) signal. When switch 2 is in the on position, no tone burst occurs. In this case, the hybrid adapts on send audio only. Adaption may be less than ideal in this mode of operation.

Switch 3: "acoustic ducker" enable. When on, a ducking function is inserted into the *send* audio path. Please see section 3.5 of the manual for a description of this function.

Switch 4: output processing disable. When in the on position, the output processing of the Telos 100 is *disabled.* When in the off position, processing is *enabled.*

Null Trimpot

The Null trimpot sets the "central range" of the hybrid.

THIS ADJUSTMENT SHOULD BE MADE UPON ANY NEW INSTALLATION.

To make the null adjustment:

1) Switch the #1 dip switch to ON.

2) Establish normal connection to phone line by calling in from another phone and turning the Telos 100 on.

3) Adjust output level trimmer for on-scale indication on output LED meter.

4) Adjust NULL trimmer for minimum reading on output meter. If necessary, readjust output trimpot to maintain an on-scale indication on the output meter.

5) Restore dip switch.

Note: while in the null mode, dip switch #4 has a different function than usual; it connects the output to a point after *the adaptive hybrid, but* before *the output audio processing. This function is provided to allow trans-hybrid loss measurements without being "fooled" by the processing.*

Rotary Switch

The rotary switch is used to select a system hybrid number in multiple-hybrid systems connected via serial ports. It currently has no effect in single-line or non-serial-controlled multiple hybrid systems.

3.3 METERING

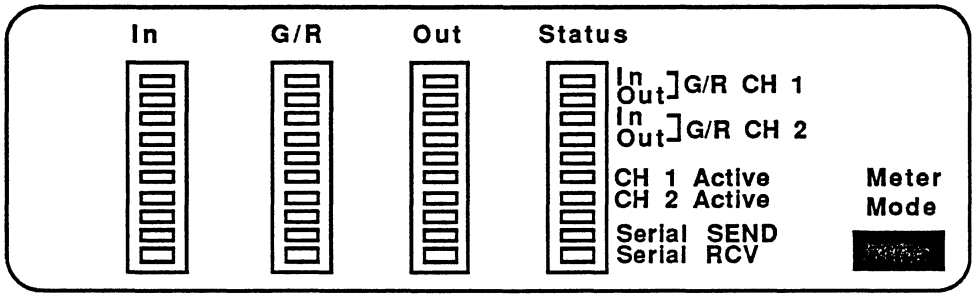
The LED metering indicates:

Input level
Channel 1 & channel 2 output levels
Input gain reduction
Output gain reduction

The IN meter always indicates the caller audio input level.

The G/R (Gain Reduction) and OUT meter indications are affected by the METER MODE switch. When the METER MODE button is pressed, the mode moves sequentially through the four states as follows:

STATE	G/R Meter Indication	OUT Meter Indication
1	INPUT GAIN REDUCTION	CHANNEL 1 OUTPUT
2	OUTPUT GAIN REDUCTION	CHANNEL 1 OUTPUT
3	INPUT GAIN REDUCTION	CHANNEL 2 OUTPUT
4	OUTPUT GAIN REDUCTION	CHANNEL 2 OUTPUT



Front panel meters.

The STATUS LEDS indicates the mode of the G/R and OUT meters.

The STATUS LEDS also indicate channel active status and serial port activity. When the serial control port is not used (as is most likely the case), the serial SEND and serial RCV LEDS will always be off. The CH1 and CH2 active LEDS will light when the unit is active.

3.4 FEEDBACK CONTROL

Sometimes, even with the exceptional trans-hybrid loss produced by the digital process, trouble with feedback may occur when the system is being used with an open speaker. Generally, this happens only with poorer phone lines, or with very weak callers requiring lots of gain in the phone-to-speaker path.

Some suggestions for solution of this problem:

1) Enable the "acoustic ducker" function. See section 3.5.

2) When mic processing is being used, connect the hybrid input in such a way that it gets the *unprocessed* mic signal. The problem here is that the mic processing combines with the internal Telos input AGC to increase gain in the feedback path when no announcer audio is present. Depending on the mic processor, the feedback margin could be reduced by many dB. The Telos' internal AGC has a smart adaptive gate to prevent inappropriate gain increase, but it is thwarted by additional processing. If it is not possible to wire around the processing, try to set the mic processing gate function so that the gain is not "sucked-up" during pauses. You might also try reducing the input level to the hybrid. The send level will still be OK, since the AGC has considerable range, but the system won't have as much room to reach for gain.

3) Try repositioning the mikes and/or speaker. Of course, it also helps to use mikes and speakers that are directional. In typical broadcast studio application. EV RE-20's and Shure SM-7's have proven appropriate.

4) Add equalization to the monitor path. Acoustic resonances usually cause pronounced peaks in the "feedback response" of a sound system. Since the largest peaks generally occur at just a few frequencies, reducing system gain at these frequencies with a graphic or notch EQ helps tremendously. UREI makes a special EQ unit just for this purpose.

5) Use a pitch shifter on the SEND input to the Telos. Pitch shifters are very useful in the application. Good results have been obtained with inexpensive "semi-pro" units, such as those made by Roland and available at music stores.

6) If necessary, soften acoustic reflections in your studio by adding curtains or wall treatment.

The foregoing is intended to help in those situations where you MUST have an open speaker. Whenever possible, it is best to use headphones to hear callers. When you have an open speaker, the on-air phone audio has both a direct and an acoustic path - from the speaker to the announce mike(s). Depending on the relative levels, phone audio quality may suffer.

The best thing in normal radio studio use is to have the announce mikes active to the phone system input even when the mike channel is switched off, and have the phone monitor speaker mute when the mike is turned on. Thus, the system can be used like a speaker phone to take calls off the air; but, when the call is to be used on-air and the announce mike is on, the speaker is muted.

3.5 THE "ACOUSTIC DUCKER" FUNCTION

A Telos innovation, the acoustic ducker is a powerful tool to prevent feedback when open speakers are being used to monitor callers. Also, because with an open monitor callers hear themselves fed back via the acoustic path from the speaker to the announce mike, this function may have the additional benefit of allowing the caller to perceive a more natural sounding conversation.

The acoustic ducker works by reducing the send (announcer) signal dynamically when the caller speaks. The time constant is very fast, so it may not be noticed by the caller. The only disadvantage might be that the announcer may be less able to break in on a caller who is insisting upon shouting on. *Note that this function in no way affects the full-duplex quality of the on-air conversation.*

The acoustic ducker is enabled by turning DIP switch #3 on.

SECTION 4 - THEORY OF OPERATION

4.1 OVERVIEW

Philosophy

In the past few years, the nature of broadcast engineering has changed considerably. At many stations, the engineering staff has been reduced in size and new responsibilities have been added. At the same time, equipment has gotten more complicated and specialized. Thus, many practitioners of the broadcast electronic arts are forced to become "systems" engineers, emphasizing equipment application rather than component-level troubleshooting.

This is probably a positive development, in a way, since it really would be impossible for a station engineer to fully understand the internal nuances of all the wonderful new high-tech stuff that is now available to improve station operations! Also, as equipment becomes more sophisticated and specialized, stocking spare parts for every eventuality has become difficult.

Thus, we at Telos don't really expect that much component-level troubleshooting will occur. So, to support you when you need help, we keep spare boards available for fast overnight shipping. In most cases, we will swap boards with you at no cost. In the four years since we introduced the Telos 10, we have not yet charged for a repair.

However, despite the comments above, we do provide full schematics and component level troubleshooting information in case you have the need or desire to tackle a repair (or modification) yourself. Another reason we provide the information is to satisfy your curiosity. If you are like me, you probably just *have* to know what's happnin' inside the fancy box. So we tell ya.

General Troubleshooting Information

Removal of the main PC Board: In addition to the obvious screws and connectors, the three XLR connectors have retaining screws which have to be turned in order for the board to be removed. See the page titled *XLR Connector Release & Knob Removal* in the DRAWINGS section of his

manuual for information on how to do this.

Removal of the front panel PC board: First the knobs have to come off. See the page titled *XLR Connector Release & Knob Removal* in the DRAWINGS section of his manuual for information on how to do this. Then remove the six Phillips head screws that secure the circuit board to the panel. The board can now be removed. Be careful not to damage the ON/OFF LEDS when removing the board.

Desoldering: While we socket the IC's that have the greatest potential for failure, many of the Telos 100 IC's are soldered-in. That's because most of the time the socket is more likely to cause trouble than the IC. This is of no consolation when one of the soldered IC's appears to have failed. When you need to replace a soldered-in chip, the right tool is essential. We use a vacuum desoldering system made by Pace (the MBT-100) and highly recommend it. Cost is about $450 - worth it if you do much PC board troubleshooting work. The only other real alternative is to clip the leads from the top and remove the solder from the holes with solder-wick. We've not had much luck with the non-heated, manual vacuum desoldering devices like the one from Radio Shack. We do not recommend that newly-soldered connections be defluxed.

Digital Signal Processing

Because the Telos 100 hybrid makes use of digital signal processing for functions traditionally done in analog, the hardware design of the hybrid is relatively uncomplicated and straightforward. In many ways, the hardware is a "textbook" implementation of a general-purpose processing system. Indeed, one of our staff has threatened to program the box to be a digital guitar processor!

As in any DSP system, the input signals are passed through anti-aliasing low-pass filters to remove signal components above the Nyquist frequency. In this case, the Nyquist frequency is 8 KHz and the ultimate sampling rate is 16 KHz.

After A/D conversion, the signals are presented to the TMS320C25 DSP processor, where software performs the hybrid and processing functions.

Then, the signals are converted back to analog and filtered to "re-construct" the desired analog audio.

Notation

Whenever a slash (/) is used after a signal designation in the text or on the schematics, an active low is signified.

Different Versions

The Telos 100 hybrid is expected to be expandable to a two channel version with a separate hybrid for each line at some time in the future. That's why there are some un-stuffed holes on the PC board. Also, the serial port is not present in most units, as it only has utility in large multi-hybrid custom systems.

4.2 DIGITAL SECTION

4.2.1 Theory of Operation

The Processor and Bus

(Refer to the Processor & I/O Logic Schematic in the DRAWINGS section of this manual.)

The TMS320C25 is a specialized high-speed processor intended for signal processing applications. Despite its unique properties, it operates much like any other microcomputer from a hardware standpoint.

Program store is provided by the two high-speed EPROMS (U8 & U9). These connect to the bus and are selected directly by the 320C25's assertion of STRB/, PS/(Program Select/) , and R/(W/).

U19, an AC138, provides the chip select signals decoded in the usual microprocessor way. by expanding the lower address lines

CS7/ is used to trigger a watchdog timer at regular intervals. If processor

operation should fail, the watchdog reacts by asserting RES/ to the processor, thus restarting it. The watchdog also provides a reliable reset when the +5 V power supply drops below 4.5 V.

U11 and U15 combine to generate a signal called GATED IACK/ (INTERRUPT ACKNOWLEDGE). which is used to reset the interrupt flip-flops used to signal interrupts produced by the A-to-D timing section.

U31, is an output port used for the G/R meter, the on and off leds and the line relays. U45 buffers the relay signal in order to provide sufficient drive current for them. Diode suppression is built-in to the driver chip.

U24 is an input port used for the rotary BCD switch and the dip switch on the front panel.

The circuit associated with U4 and JP3 allow for one wait state to be generated for I/O operations. In current versions, the jumper is set for no wait states, and fast I/O chips are used.

A/D and Timing Section

(Refer to A/D and Timing Section Schematic in the DRAWINGS section of this manual.)

The timing chain starts with a 40 MHz clock oscillator module. The 40 MHz output is fed directly to the 320C25. The HC390, U2 divides the 40 MHz to 4 MHz in order the drive the clock input of the A/D converters and the 8748 µP, if used.

The HC393 further divides the signal to 15.625 KHz in order to drive the Frame-Sync input to the A/D's and, after being decoded by U28, the interrupt signals to the processor, signifying a completed conversion by one of the A/D's. After each interrupt, the GATED IACK/(interrupt acknowledge) resets the associated flip-flop.

U30, a 153 data selector routes the active A/D converter's serial output bit stream and data clock to the 299 serial to parallel converters, U22 & 23.

These IC's also have a tri-state bus compatible output which enables the A/D data onto the bus for reading by the processor.

D/A Section

(Refer to D/A Section Schematic in the DRAWINGS section of this manual.)

The output D/A, a Burr Brown PCM53, requires a parallel data input, so interfacing is to the 16 bit bus through U20, 21, bus interface chips. U18 provides control for the DG201 analog switches. The Telos 100 uses a multiplexing scheme to get up to four data outputs from the single D/A converter. C24-27 provide the required hold function.

Serial Port

(Refer to the Serial/Phone Relays Schematic)

On systems with a large number of hybrids, the serial port is used for communication. An 8748 µP is used to make a "smart UART" which converts the serial input to parallel and provides channel decoding. It is connected to the serial port through the LT1080 which converts the processor's TTL I/O levels to ±9V RS-232 serial levels. The LT1080 has the voltage converter built-in.

An input port to the main 320C25 bus provided by U17 allows communication from the 8748 to the DSP. U17 also gets the front panel (and remote) on/off and Meter Mode buttons into the DSP chip.

An output port from the DSP bus to the 8748 provides communication in the other direction. This chip is not stuffed in units with no serial port as it has no other function.

Note that the BCD switch parallels to both the 8748 and an 320C25 input port, so that it has full flexibility in use. This switch is used for channel assignment in serial systems.

Front Panel

U7, a 74107, is used as a simple four position counter for the meter status selector. Each time the Meter Mode switch is pressed, the counter advances one count. The 145, U4, is a decoder which drives the meter status leds. The high-order counter bit goes to the analog switch U5 in order to select either output channel 1 or 2 for display on the led output meter. The low order bit goes to the DSP processor through input port U17 to tell it which G/R indication to send to the G/R led display.

Note that the system reset (RES/) causes U7 to reset to status position 1 whenever a reset occurs. This may be useful in order to detect spurious or undesired resets. In order to do this, leave the meter in a position other than 1 and observe to see if a reset caused it to go to mode 1.

The 74145, U2, decodes the four G/R bits coming from the DSP into the ten segments on the led meter.

The other front panel digital functions are straightforward.

4.2.2 Troubleshooting the Digital Section

If digital section problems are suspected, start with the power supply.

Check the 40 MHz oscillator output and the divided-down clock signals to see that they are OK.

Unlike TTL, the CMOS logic IC's used in the Telos 100 Hybrid should have a nice almost rail-to-rail output.

Make sure that all of the required signals are getting to the A/D and that the A/D's are outputting both data and the data clock. Both are easily visible on a scope.

None of the logic section IC's should get hot, so if any is, you've found the problem. On rare occasions, a CMOS chip may latch up and get hot, but recover and work normally when power is removed fro awhile and restored.

Check the 16 data bus lines to see if any are shorted. They should all exhibit lots of activity, as should the lower address bits.

4.3 AUDIO SECTION

4.3.1 Theory of Operation

(Refer to the Block Diagram and the appropriate audio section schematics in the DRAWINGS section of this manual.)

Input

The audio input goes first to U42 for conversion from balanced to unbalanced. The input is protected from RF by the TDK PI filters RF5 & 6. JP5 allows insertion of special circuit cards. From here, the input audio travels to the front panel where it encounters the input gain trimmer, from which it returns to feed the input anti-aliasing filter, a 3rd order elliptical variety implemented in Negative Impedance Converter (NIC) form for stability. The filter is down -60 dB at the Nyquist frequency, 8 KHz. Its roll-off begins at around 3.6 KHz. Diodes D3, 4 provide a safety clipper function. The output of the filter is fed directly to the A/D converter, U34.

Output

The appropriate demultiplexed output from the D/A section is sent to the output reconstruction (smoothing) filter, a 5th order Chebychev type. The signal is then routed to the front panel output trimmers and is then returned to feed the two output balancing stages. As in the input, the audio is protected from RF by PI filter devices.

Phone Audio Section/Fixed Active Hybrid

A simple fixed active hybrid (see Q & A section) is implemented to provide the first crude rejection of send from receive audio. The front panel null trimmer sets the balance of this hybrid.

A 3rd order Chebychev filter provides the reconstruction function for the audio from the D/A which sends to the phone.

A 3rd order elliptical identical to the input filter is used for anti-aliasing of the audio from the phone line. U33 is the A/D converter used for the

phone signal conversion.

Front Panel

The two led bar meters which indicate audio level are driven from simple full-wave rectifier circuit sections. The 3915's are self-contained audio meter drivers.

Analog switch U5 selects the output 1 or 2 signal for display on the output meter.

4.3.1 Troubleshooting the Audio Section

The audio section is textbook simple and can be easily debugged by using a scope for signal tracing.

All chips should run cool except for non-Signetics brand 5532's - *it is normal for these to run hot.* The PCM53 D/A runs warm, but not hot.

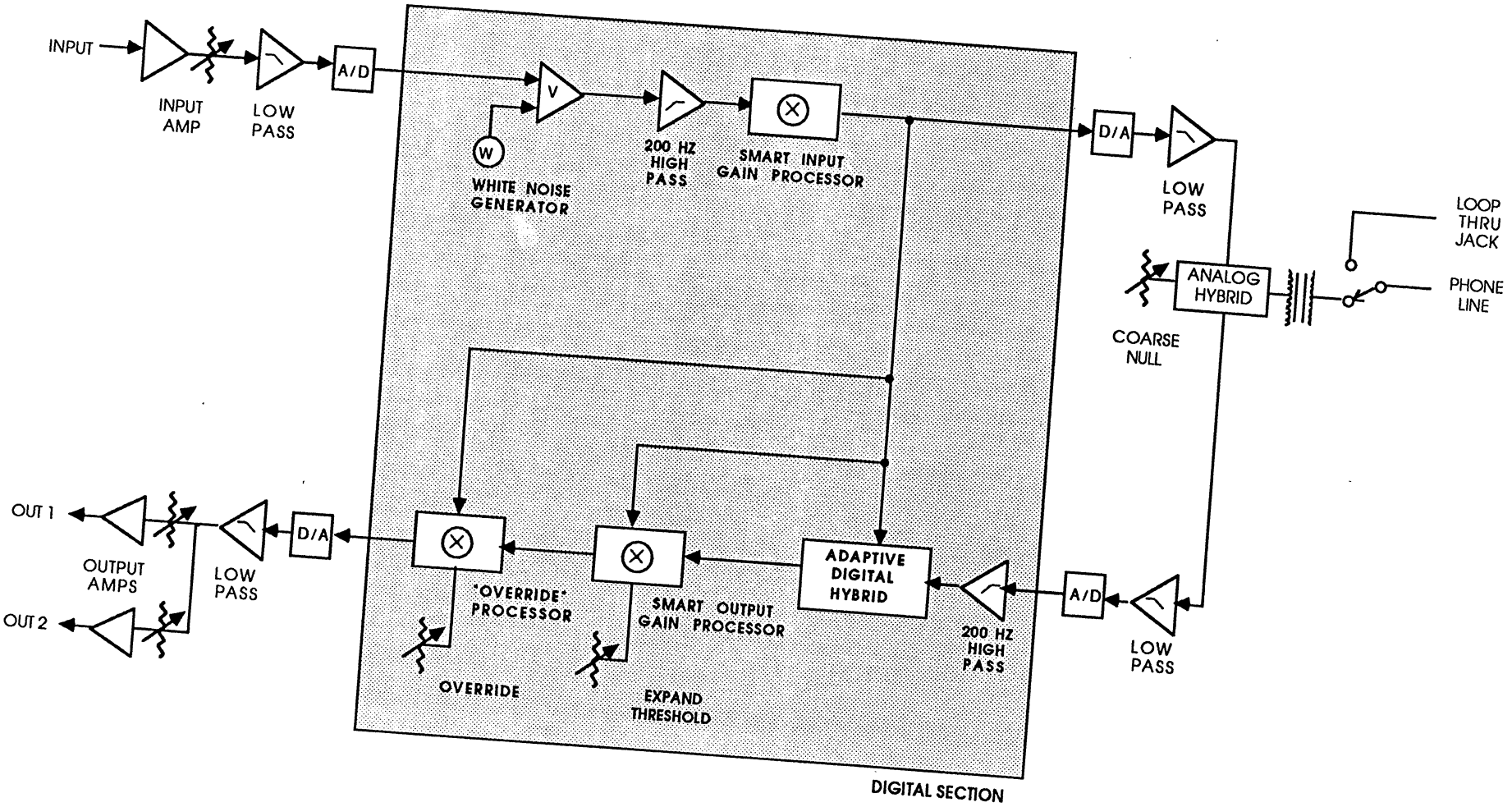
4.4 POWER SUPPLY

The power supply is a simple straightforward design using 3-terminal regulators, with two exceptions: the coil and the gold cap. Both are used to help make the system immune to power glitches. The coil offers resistance to high frequency spikes and surges, while the gold cap holds the power up during brief power dips or failures. The jumper is provided to take the gold cap out of the circuit for troubleshooting purposes. It is sometimes annoying to have to wait the few minutes it takes the gold cap to discharge. It is rated at 3.3 *Farads!*

An MOV is used on the power input AC side to further protect against AC surges.

SECTION 5 - DRAWINGS

INDEX TO DRAWINGS:



TELOS 100 SIGNAL FLOW DIAGRAM

TELOS 100 MODIFICATION FOR FOUR-WIRE USE

For connection to four-wire systems, the internal Telos 100 active op-amp hybrid is converted into an input and output amplifier section. A switch is added to the rear panel to allow selection of 2 or 4-wire operation. The modification is simple and is shown on the attached schematic diagram.

After modification, when the added rear-panel switch is in the "4-wire" position the following applies :

Send Output

- Appears at modular jack J1.
- Is at a nominal level of -10 dBm, with peaks to 0 dBm.
- Is transformer balanced.
- Approximate source impedance is 800 Ω .
  (for connectionto 600-900 Ω load)

Receive Input

- Should go to modular jack J2.
- Should be a nominal -20 to -10 dBm. Clip point is 0 dBm.
- Is transformer balanced.
- Load impedance is 800 Ω.
  (for connection to 600-900 Ω source)

Of course, other levels may be accomodated by changing the appropriate resistor values.

The COARSE NULL trimmer continues to function in the usual fashion and should be adjusted per the manual's instructions.

With the switch in the "2-wire" position, the unit operates as usual.

FOUR-WIRE CONVERSION OF TELOS 100 DIGITAL HYBRID

These are the directions to perform a 2-to-4-wire conversion of a Telos 100 Digital Hybrid. Please follow them carefully to ensure correct operation of the unit in the 4-wire mode.

1) REMOVE
the PC board from the unit. First, disconnect the power supply and the front panel ribbon connector. Now remove the six mounting screws on the board and the two screws that hold the DB25 connector. Also release the XLR connectors as shown on XLR removal page (enclosed).

2) DESOLDER
the jumper that is where T2 should be (next to T1). REPLACE the jumper in the two outsidemost holes of RF8.

3) SOLDER
in T2 (PREM part no. SPT 117).

4) SOLDER
in one 820Ω resistor as follows: one end goes to ground, found at pin 3 of U43 (U43 should not be stuffed); the other end goes to R74's feed-thru hole nearest the edge of the PC board (R74 is also not stuffed). This is the point where T2 connects to the 820Ω resistor and R76.

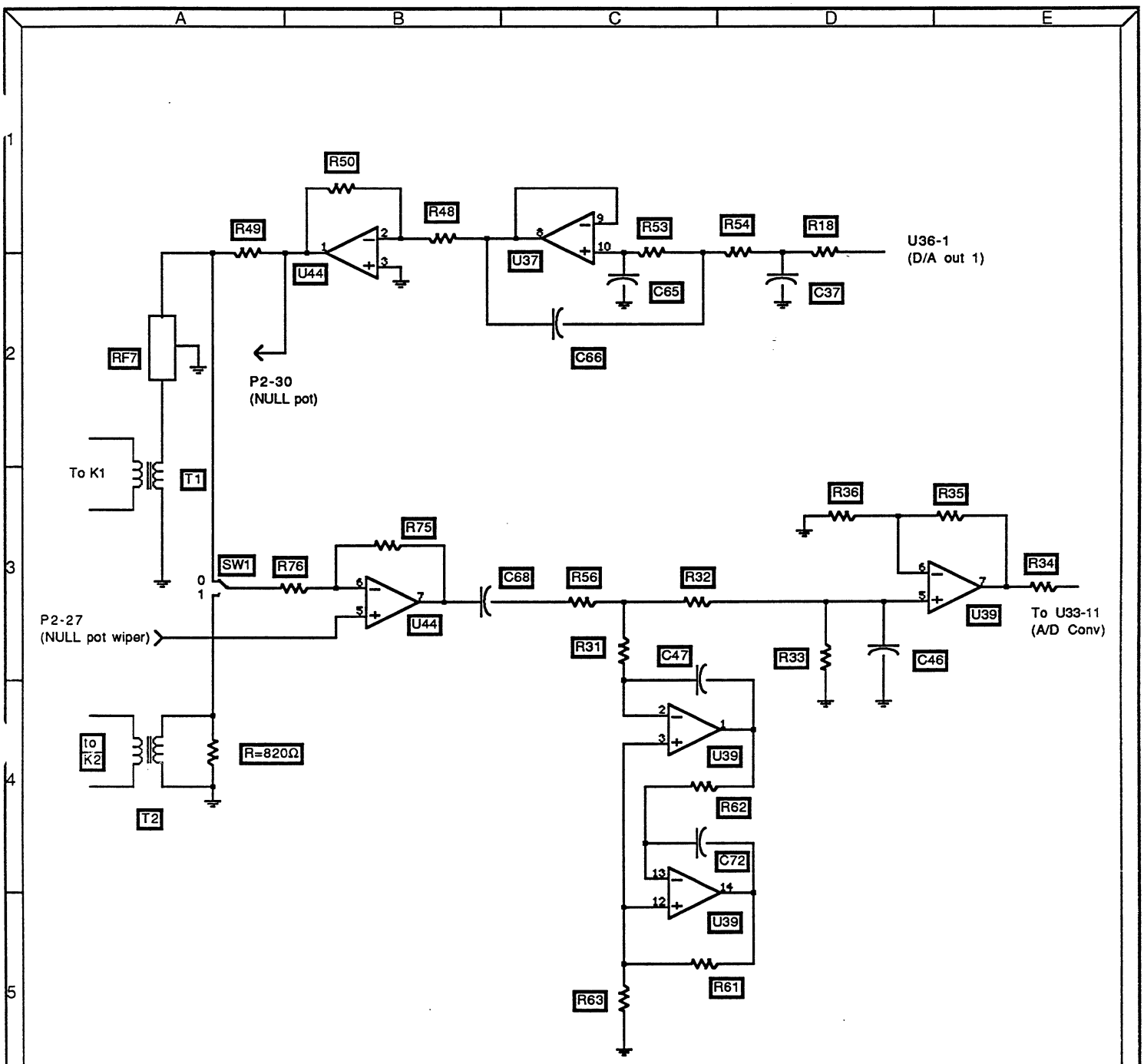
5) DESOLDER
R76's lead that is nearest the edge of the PC board. Carefully swing R76 over to the 820Ω resistor and SOLDER them together as per the schematic (also enclosed). Be careful not to let R76 touch R75's leads.

6) CHECK
connections with an ohmmeter to verify solder joints and accuracy of work.

7) REPLACE
the PC board carefully in the main unit. Remember to retighten the XLRs.

8) Finaliy, MOVE
jumpers JP1 and JP2 from the "2-3" position to the "1-2" position.

An SPST switch can be added to the circuit to make the unit switchable from 2-wire operation to 4-wire operation. We recommend drilling a hole for the switch next to the modular phone jacks. It's also a good idea to use solderless connectors on the switch so that PC board removal won't require any desoldering.



TELOS 100 HYBRID
Phone Audio Section
with 2-to-4 wire option
SW1 in 2-wire position

AUTO-ANSWER BOARD

Introduction

The auto-answer board is used when automatic answering and hang-up of the Telos 100 hybrid is desired. The circuit turns the hybrid on in response to ringing voltage on the connected phone line, and turns the hybrid off when a break in loop current is detected.

The loop current interruption, often referred to as "CPC," or Called Party Control, is present on most telephone lines. However, some central office equipment may not provide it and other detection methods will have to be used in that case.

Installation

The board is installed by plugging it into the header connectors HR1, HR2, and JP5 on the main Telos 100 board near the modular phone jacks. Remove the small jumper plugs on JP5 first.

The auto-answer board should be removed and the jumpers replaced if use with other than Central Office-type lines with talk battery is expected, since the diodes in the loop detect section will cause severe audio distortion if not biased by talk battery.

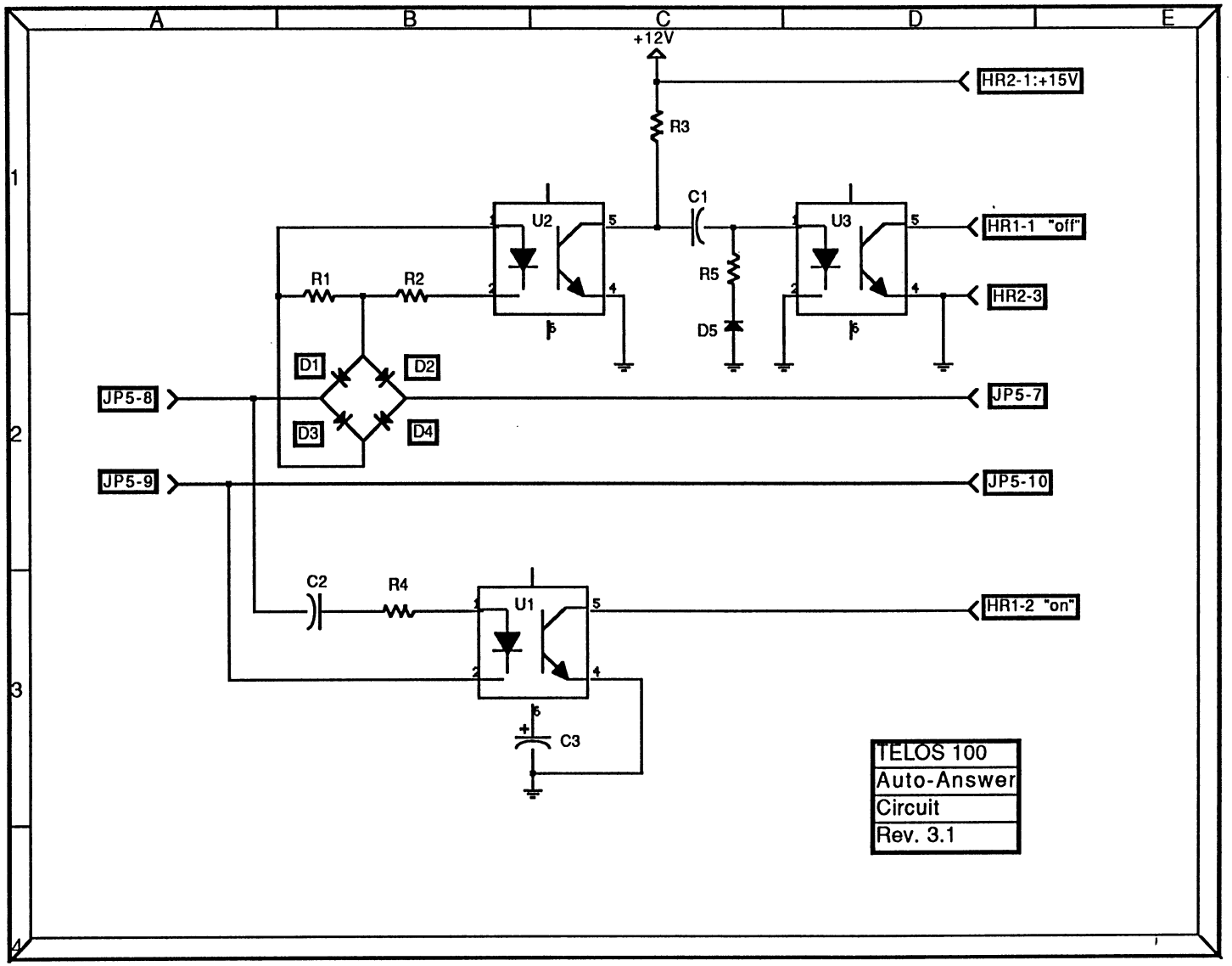
Operation

Not much excitement here. With the board installed, the hybrid will automatically answer and hang-up.

Circuit Description

U1, R4, and C2 form the ring detect section. C2 blocks DC so that only the AC ring voltage will trigger U1. When U1's diode gets current, its transistor pulls HR1-2 low turning the hybrid on. C3 prevents false tripping.

The remaining components form the loop current detector. When loop current is present, U2's transistor conducts and C1 is discharged. When loop current goes away, C1 charges through the diode in U3 thus causing a low at HR1-1 for the length of the R3/C1 time constant. Upon restoration of loop current, the capacitor discharges through R5 and D5. The C1/R5 time constant prevents falsing during initial answer by preventing C1 discharge on brief periods of loop current presence.


A
B
C
D
E
1
2
3
4
+12V
HR2-1:+15V
R3
C1
U2
U3
HR1-1 "off"
HR2-3
R1
R2
R5
D5
D1
D2
D3
D4
JP5-8
JP5-7
JP5-9
JP5-10
C2
R4
U1
HR1-2 "on"
C3
TELOS 100
Auto-Answer
Circuit
Rev. 3.1

WARRANTY and Application Caution

The Telos 100 is warranted to be free from defects in material and workmanship for a period of 120 days. Written notice of claim must be received by seller within the warranty period. In the event of a defect during the warranty period, if customer returns the defective part or the Telos 100 to a place designated by the seller, transportation prepaid, seller at its option, will either repair or replace the part or the Telos 100, and such action by seller shall be the full extent of seller's obligation hereunder. Seller will pay the transportation charges to return the part or unit to the customer. Of course, the warranty is void if the unit is subject to misuse, accident, neglect or damage.

No other warranties express or implied, all of which are specifically excluded, including, but not limited to, the warranties of merchantability or fitness for a particular purpose, shall be applicable to any equipment sold hereunder, and the foregoing shall constitute the sole right and remedy. In no event shall the seller or it's agents be liable for incidental or consequential damages, or for loss, damage, or expense directly or indirectly arising from use of the products, or any inability to use them either separate or in combination with other equipment or materials, or from any other cause.

The Telos 100 Interface is intended to be used with FCC registered protective interface devices. A registered protected Key Service Unit meets this requirement.

SECTION 7 - TELEPHONE Q & A

General Information on Broadcast Telephone Interface