

BUILD THE PARTY LINE

Construction and configuration details for a super-slick phone-line simulator.

LAST TIME WE PRESENTED AN OVERVIEW of Party Line, an inexpensive phone-line simulator that provides authentic dial, ring, and busy signals, supports Caller ID and Distinctive Ringing, and can even be used as the hub of a six-line intercom system. For a detailed description of features and functions, as well as an overview of how it works, see last month's issue.

This month we'll dive right into the details of how it works. Recall that the circuit consists of five major sections: Input, step-up, microcontroller, DTMF decoder and call-progress generator, and power. Also, there are three separate grounds (analog, digital, and high-current), which unite at the power supply.

MCU circuit and software

Figure 3 shows the microcontroller (MCU) portion of the circuit. A PIC16C57 provides all system intelligence. The PIC is a member of Microchip Technology's family of high-performance, low-cost, 8-bit microcontrollers. Features include 2K

THOMAS E. BLACK

of ROM, 72 bytes of RAM, 20 digital I/O pins, and very low power consumption—all in a compact 28-pin package. For more information on the PIC family, contact Microchip Technology, Inc., 2355 West Chandler Blvd., Chandler, AZ 85224-6199. Tel: (602) 963-7373, Fax: (602) 899-9210.

The MCU's internal ROM holds the software—more accurately, *firmware*—that controls Party Line. (Firmware is non-volatile, which means that it isn't lost when power is turned off). Firmware-controlled functions such as Ring Generation, Tone Detection, and Relay Control are event-driven, so all features work together seamlessly. Unlike simple loop-controlled programs, Party Line's design uses a time-based task scheduler to control hardware operation.

Programming the microcontroller with the Party Line firmware requires special equipment. If you don't have ac-

cess to the requisite equipment, pre-programmed MCUs are available as mentioned in the Parts List.

The firmware is copyright protected and is not public domain—it cannot be freely copied or distributed. However, you can use the PL6.OBJ software in your personal project at no charge just by downloading it from the Gernsback BBS. You will find it under the name PL6.ZIP. Please review the Hobbyware information included in the companion README.TXT file for full details about using the firmware in your personal project.

Time and date

Time information broadcast by the Caller-ID function comes from a software-maintained 24-hour clock. Unlike your personal computer, Party Line does not use a dedicated chip to maintain time. Instead, a one-second counter is obtained using the MCU's internal counter and dividing the oscillator frequency. The hour and minute data is derived from the counter. The real

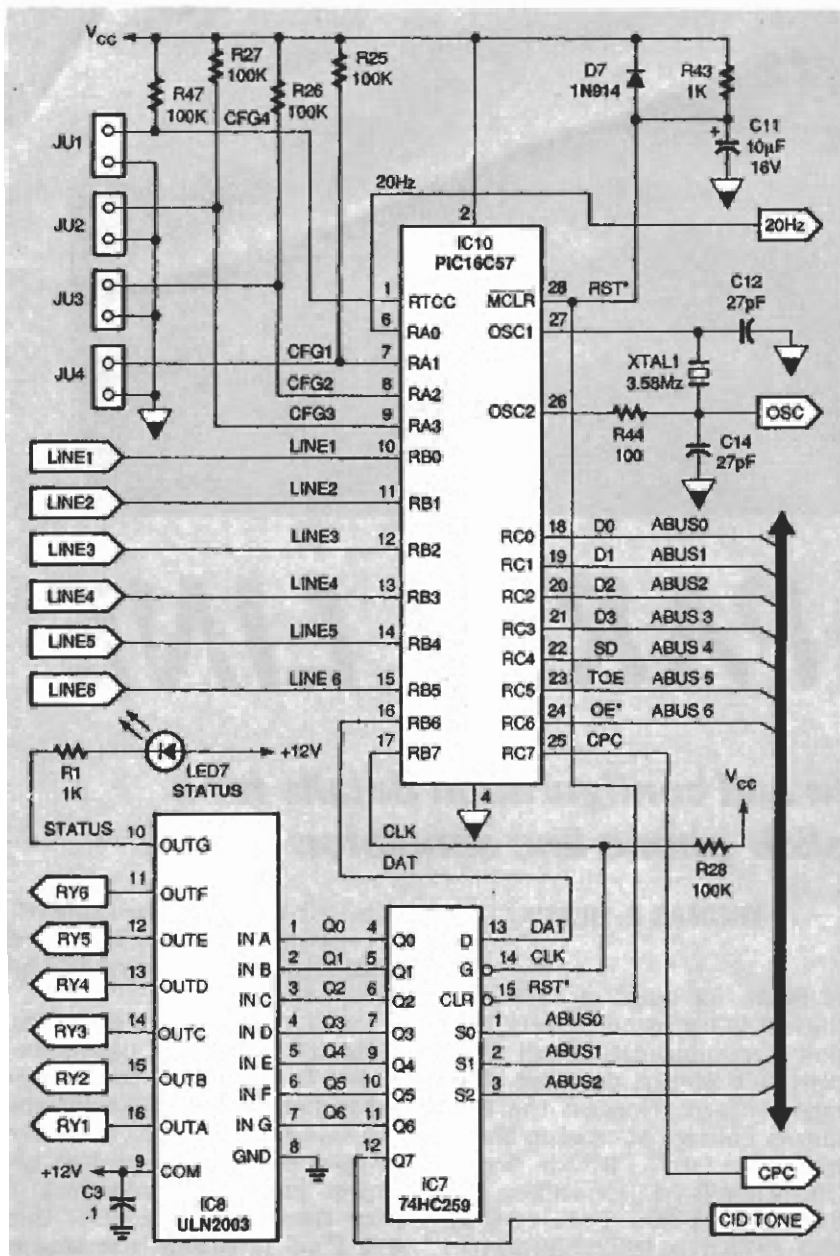


FIG. 3—THE MICROCONTROLLER reads line status from all six stations and controls their connections to the talk and ring circuits.

time clock function has been included so that you can experiment with Caller-ID products, but the clock is not designed as a precision timepiece; it may gain or lose a few seconds each day.

Unfortunately, because of limited ROM space, we were unable to include a date-tracking function. Thus, if you want the Called-ID date display to show the correct date, you must manually update the date on a daily basis.

Because the time (and date) information is stored in the

MCU's volatile RAM, it will be lost whenever the MCU resets, such as when AC power is lost. The default date is Jan 1, and the default time is 12:00 am.

I/O control

The MCU's I/O lines monitor the hookswitch- and DTMF-decoder signals, operate the six line relays, and control the call-progress tone generator.

The twenty I/O lines consist of three port groups, A, B, and C. Ports B and C have eight lines apiece (RB0-RB7 and RC0-RC7, respectively), and

Port A has four lines (RA0-RA3). The software configures RA0, RB6, RB7, and RC5-RC7 as outputs; RA1-RA3, RB0-RB5, and RC4 as inputs; and RC0-RC3 are used bidirectionally. A special MCU input signal, RTCC, is normally used as a counter input, but a software trick allows it to be used as an additional input port for configuration control.

In conjunction with RTCC, the RA1-RA3 inputs determine start-up configuration values, and RB0-RB5 monitor the optoisolated loop detectors that indicate when a phone goes off-hook.

The RC0-RC3 lines form a miniature data bus for reading DTMF codes from IC15 (Fig. 7), writing call-progress tone codes to IC14, and writing relay codes to IC7, an eight-bit addressable latch. In addition, MCU outputs RB6, RB7, RC5, and RC6 form the control signals for the bus; their job is to ensure that the correct data is read from or written to the right place at the right time. For example, to output a bit to the addressable latch (IC7), you would place data (0 or 1) on MCU signal RB6, the address (0-8) of the desired latch on RC0-RC2, and then toggle RB7 low.

Control line RC5 triggers a read of DTMF values from IC15, and RC6 latches call-progress tone codes into IC14. The RC4 input is normally low; the DTMF decoder drives it high when it detects a valid signal.

The last I/O bit to discuss is RA0. Its job is to provide the 20-Hz ring signal used by the step-up circuit. Low-end telephone simulators often use a 60-Hz ring signal because it is easily derived from the AC power line. However, some phone equipment will not operate correctly with a 60-Hz signal. To ensure compatibility, we use an accurate, software-generated ring signal.

The ring signal generated by the MCU must be isolated and stepped up to drive the telephone line talk circuit. As shown in Fig. 4, the high voltage is generated by push-pull

Continued on page 71

PARTY LINE

continued from page 36

power transistors Q1 and Q2, which in turn drive step-up

transformer T1. Note that T1 is used "backward:" its low-voltage secondary is driven, and its output is derived from the high-voltage primary. The output of T1 is about 90 volts AC. Ideally,

that output would be a clean sine wave. Although most equipment will not be bothered by the harmonics present in the T1 output, there is a possibility that some might be.

Caller ID modulator

Caller-ID delivers its information in a 1200 bit-per-second (bps) serial modem-tone format formally known as Bell 202. Under Bell 202, a high is a 1200-Hz tone, a low is a 2200-Hz tone, and the nominal signal level is -13.5 dBm.

Party Line uses a clever technique to reproduce these modulated tones. Instead of a traditional hardware-based solution, a software process called *bit-banging* creates the tones. Bit-banging can often both improve reliability and reduce cost in comparison with hardware methods. Under MCU control, the high bit of addressable latch IC7 (returning to Fig. 3) is used to create the Caller-ID (CID) tone.

In operation, Party Line waits for the first ring, temporarily removes the caller's phone from the talk path (via the line relays), then carefully manipulates IC7's Q7 output to con-

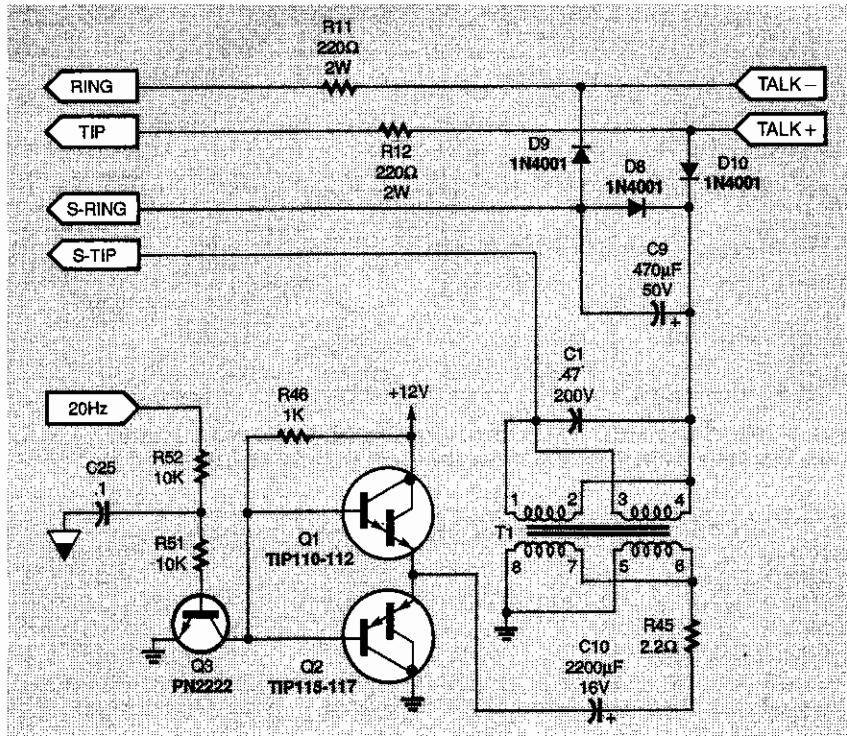


FIG. 4—THE STEP-UP CIRCUIT creates a 90-volt AC ring signal by driving transformer T1 via push-pull amplifier Q1 and Q2. The 20-Hz signal is generated under software control by the microcontroller.

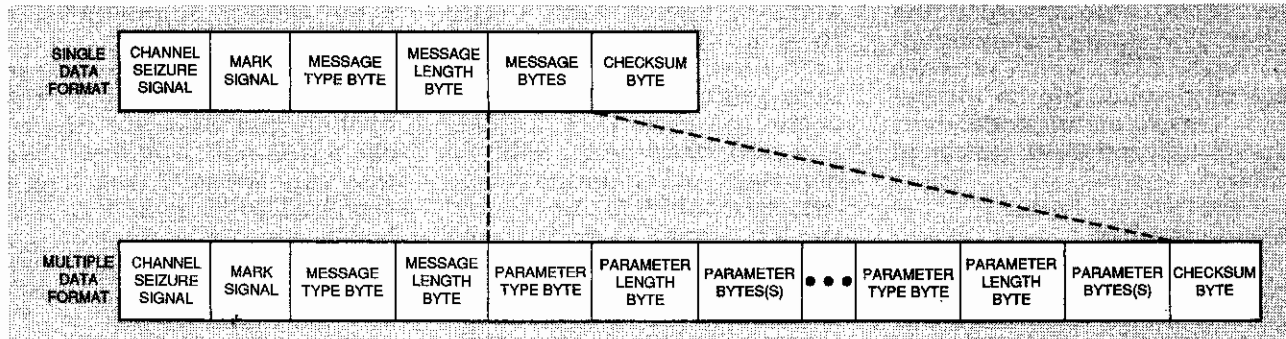


FIG. 5—CALLER-ID MESSAGE FORMATS ARE VERY SIMILAR. The Single Data Message Format includes a single message; the Multiple format inserts multiple messages in the parameter block used by the simple message.

TABLE 4—CALLER ID MESSAGE FORMAT

Message	Description
Power Ring	Not shown. The first ring is called the power ring. It is used to get the attention of the Caller-ID receiver. The ring is followed by 500 ms of silence.
Channel Seizure	Sync bytes, consisting of 30 ASCII U's (250 ms duration).
Mark Signal	1200-Hz marking tone, 150 ms duration.
Message	Message (or parameter) type, length, message bytes, and checksum.
Post-Msg Mark	After message data, an 80 ms mark tone is sent (optional).
Post-Msg Silence	All tones must end at least 475 ms before the next ring.

struct the modulated tones. Although the required frequencies are fairly low, the software keeps the MCU quite busy while generating the tones.

There are two CID data formats, as shown in Fig. 5. The two are very similar, except that the expanded format essentially embeds multiple data items in the position of the single data item of the simple format. Table 4 outlines the meaning of each field of the message.

CID data is transmitted unidirectionally. In addition, the receiver makes no attempt to acknowledge message receipt. Those limitations prevent the receiver from recovering from an erroneous transfer, so even minor transmission errors usually cause the loss of all CID information.

Relay drive

Returning again to Fig. 3, a ULN2003 drives the line-control relays. That IC has an array of seven independent high-gain Darlington NPN transistors, each of which includes an internal diode to prevent EMF damage.

Whenever one of IC8's inputs goes high, the corresponding output provides a return path for the coil of the corresponding relay. The seventh Darlington controls LED7, which provides status display. Status indications corresponding to different operating conditions appear in Table 5.

Input circuitry

Figure 6 brings together several strands of the circuit sections that have been discussed so far. Note that only one of six identical circuits is shown (the part within the dashed lines); Table 6 shows corresponding part numbers for all six stations. Note that there is only one

TABLE 5—LED STATUS

State	Description
Steady On	Power is on and unit is ready
Flashing	Station is ringing
LED Off	DTMF digit is being dialed

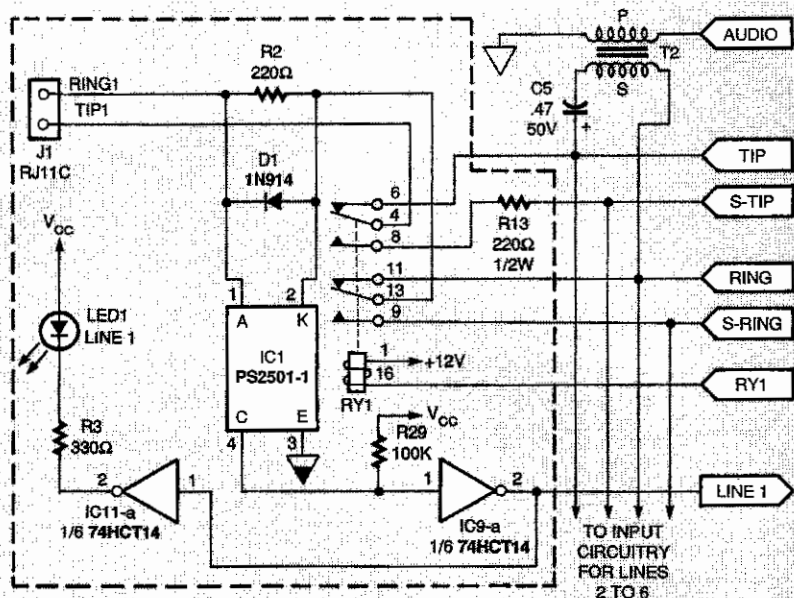


FIG. 6—INPUT CIRCUITRY: Note that everything inside the dashed lines repeats for each input line. Table 6 correlates the parts across all six circuits.

TABLE 6—LINE INPUT COMPONENTS

Line	J	R	D	IC	LED	R	IC	R	IC	RY	R
Line 1	J1	R2	D1	IC1	LED1	R3	IC11-a	R29	IC9-a	RY1	R13
Line 2	J2	R4	D2	IC2	LED2	R5	IC11-b	R30	IC9-b	RY2	R14
Line 3	J3	R16	D3	IC3	LED3	R17	IC11-c	R31	IC9-c	RY3	R15
Line 4	J4	R6	D4	IC4	LED4	R7	IC11-d	R32	IC9-d	RY4	R18
Line 5	J5	R8	D5	IC5	LED5	R9	IC11-e	R33	IC9-e	RY5	R19
Line 6	J6	R10	D6	IC6	LED6	R21	IC11-f	R34	IC9-f	RY6	R20

set of audio-coupling devices (C5 and T2) for all six stations. Also, the four lines carrying tip and ring signals form a mini "bus" to which all stations attach in parallel. In contrast, each station has its own line-active indicator (e.g., LINE1) and relay driver (e.g., RY1). As discussed earlier, the LINE_x signals drive the MCU directly, and the RY_x signals come from the ULN2003 shown in Fig. 3.

Each station contains a loop detector circuit based on an optoisolator. The optoisolator (IC1) acts as a normally open switch that closes when a telephone goes off-hook. When that happens, current will flow through the optoisolator's input, which in turn forces its output low. That signal is then buffered and inverted by one section of a hex Schmitt trigger (IC9-a), and it is that signal that informs the MCU that a station is active. That same optoisolated and buffered signal also drives an LED (LED1) that provides visual indication when a station is ac-

tive. If a telephone is plugged in, the indicator also flashes during the ring cycle. If a telephone is not plugged in, the indicator does not flash.

The loop detector circuit can detect a phone that goes off-hook during an active ring cycle, a desirable function called *ring trip*. Without ring trip, a very loud 20-Hz buzz would be heard when you answered a ringing phone. Ring trip is commonly available only on expensive phone-line simulators.

When a phone line is idle, the corresponding relay is energized. That removes each idle station from the talk path (Tip and Ring) and places it across the ring circuit (S-Tip and S-Ring) in preparation for a future ring cycle. During the active portion of a ring cycle, the MCU removes all idle stations—except for the station that is ringing—from the T1 circuit, and places them on the talk path. If you listen carefully, you can hear the relays deenergize during the ring cycle.

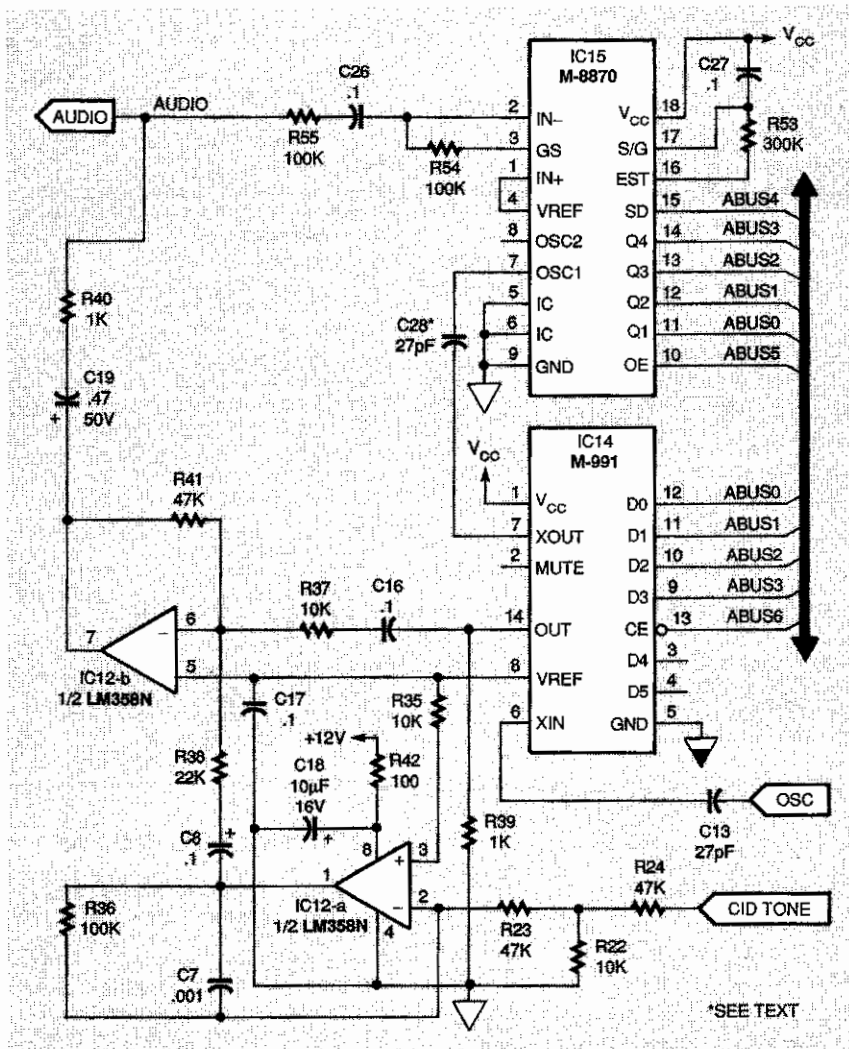


FIG. 7—TONE DETECTION AND GENERATION: IC14 generates one of several call-progress tones as determined by the binary input on its D0–D5 inputs. IC15 decodes DTMF tones and delivers them to the MCU via the 6-bit bus.

TABLE 7—DTMF CODES

Digit	D3	D2	D1	D0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0

When a station goes off-hook, the MCU deenergizes the associated line relay, which places that station on the talk path. Unless you like talking to yourself, at least two stations must be off-hook for you to carry on a conversation.

Tone decoding

Figure 7 shows how Party Line decodes incoming DTMF signals, encodes outgoing call-progress tones, and filters the MCU-generated 20-Hz ring signal.

Through use of a highly integrated DTMF tone receiver, decoding the dialed phone number is simple. Party Line uses the popular M-8870 (IC15), which is made by Teltone Corpo-

TABLE 8—DTMF TONES

Low Group	High Group		
	Column 0 1209 Hz	Column 1 1336 Hz	Column 2 1477 Hz
Row 0, 697 Hz	1	2	3
Row 1, 770 Hz	4	5	6
Row 2, 852 Hz	7	8	9
Row 3, 941 Hz	*	0	#

ration, Mitel Semiconductor, and others. The M-8870 decodes only DTMF telephone codes; it ignores rotary and pulse dialed digits. Because the M-8870 is crystal controlled, there are no adjustments to make. The IC incorporates switched-capacitor filtering to separate groups of tones.

Table 7 shows the binary code delivered by each telephone key. The DTMF encoding standard defines up to sixteen dual-tone combinations, but standard phones generate only twelve of them. The twelve keys appear in a matrix measuring four rows by three columns; those in a given row or column have one tone in common. Table 8 shows the row-column arrangement along with corresponding tones. Note: In 16-digit DTMF, there is an eighth tone (1633 Hz), which is not shown.

For example, if you press the "3" key, the phone generates 697- and 1477-Hz tones. Seven frequencies are involved in standard DTMF generation, and they are separated into two groups. The row information is called the low group; it has frequencies 697–941 Hz. The column information is called the high group; it has frequencies 1209–1477 Hz.

The codes get to the Micro-controller via bus lines ABUS0–ABUS3. The MCU periodically monitors bus line ABUS4; when it goes high, the MCU then reads the binary code from IC15. The software must decide if the tone code is new, because holding down a key will cause the tone code to be read about two hundred times per second. The software records the dialed digits as they are entered; when enough digits have been entered, the MCU starts ringing the station corresponding to the dialed number.

All resistors are 1/4-watt, 5%, unless otherwise noted.

- R1, R39, R40, R43, R46—1000 ohms
- R2, R4, R6, R8, R10, R16—220 ohms
- R3, R5, R7, R9, R17, R21, R48—330 ohms
- R11, R12—220 ohms, 2W, 5%, metal oxide
- R13—R15, R18—R20—220 ohms, 1/2W
- R22, R35, R37, R50—R52—10,000 ohms
- R23, R24, R41—47,000 ohms
- R25—R34, R36, R47, R54, R55—100,000 ohms
- R38—22,000 ohms
- R42, R44—100 ohms
- R45—2.2 ohms
- R49—470 ohms
- R53—300,000 ohms

Capacitors

- C1—0.47uF, 200V, metalized polyester
- C2—C4, C6, C8, C15—C17, C25—C27—0.1uF, 50V, monolithic, radial
- C5, C19, C20—0.47uF, 50V, electrolytic, radial
- C7—0.001uF, 50V, polyester, radial
- C9, C24—470uF, 50V, electrolytic, radial
- C10—2200uF, 16V, electrolytic, radial
- C11, C18, C22, C23—10uF, 16V, electrolytic, radial

PARTS LIST

- C12—C14, C28—27pF, 100V, COG ceramic
- C21—1000uF, 25V, electrolytic, radial
- Semiconductors**
- D1—D7—1N914 signal diode
- D8—D13—1N4002 rectifier, 1A, 100V
- BR1—50V, 1A, W005 or equiv.
- LED1—LED7—Green LED, 3mm
- Q1—TIP110 NPN Darlington transistor
- Q2—TIP115 PNP Darlington transistor
- Q3—PN2222A NPN transistor
- IC1—IC6, IC13—Optoisolator, NEC PS2501-1 or equiv.
- IC7—74HC259 or 74HCT259 addressable latch
- IC8—ULN2003 Darlington array
- IC9, IC11—74HC14 or 74HCT14 hex inverter
- IC10—PIC16C57-XT/P 8-bit Microcontroller, Microchip Tech.
- IC12—LM358N dual low-power op-amp
- IC14—M-991 Call progress tone generator, Teltone Corp.
- IC15—M-8870 DTMF decoder, Teltone Corp.
- IC16—LM317T adjustable regulator
- IC17—LM7812 or LM78M12, 12V regulator
- IC18—LM7805 or LM78M05, 5V regulator

- regulator
- Other components**
- F1—0.5A, 5 x 20mm fuse
- J1—J6—Modular RJ11, 6/2 or 6/4 receptacle, PCB Mount
- J7—1 x 3, 0.1-inch female header
- JU1—JU4—4 x 2, 0.1-inch pin header with shorting blocks
- JU5—See text
- P1—1 x 3 0.1-inch pin header
- XTAL1—3.5795 MHz, HC18
- RY1—RY6—DPDT, 12V, DC, 16—20mA coil, DIP package (OMRON G6A-234P-ST15-US-DC12 or equiv.)
- T1—Transformer, split bobbin, dual 115-VAC to dual 6.3-VAC, 2.5VA (Prem SPW401D, Magnetek/Triad FS12-200, or equiv.)
- T2—Telephone coupling transformer, 600:600 (PREM SPT130, Mouser TL016, or equiv.)
- T3—Power transformer, 28VAC center tapped, 300mA
- Miscellaneous**
- IC sockets, 4/40 hardware, TO-220 heatsinks (2 each for IC17 & IC18), AC power cord, 2.5-inch H x 8-inch W x 6-inch L plastic enclosure, PC board, IC sockets, solder, wire, etc.

TABLE 9—CALL PROGRESS CODES

Tone	Frequency	D3	D2	D1	D0
Dial	350/440	0	0	0	0
Special	400/off	0	0	0	1
Alert	440/off	0	0	1	0
Ring	440/480	0	0	1	1
Busy	480/620	0	1	1	0

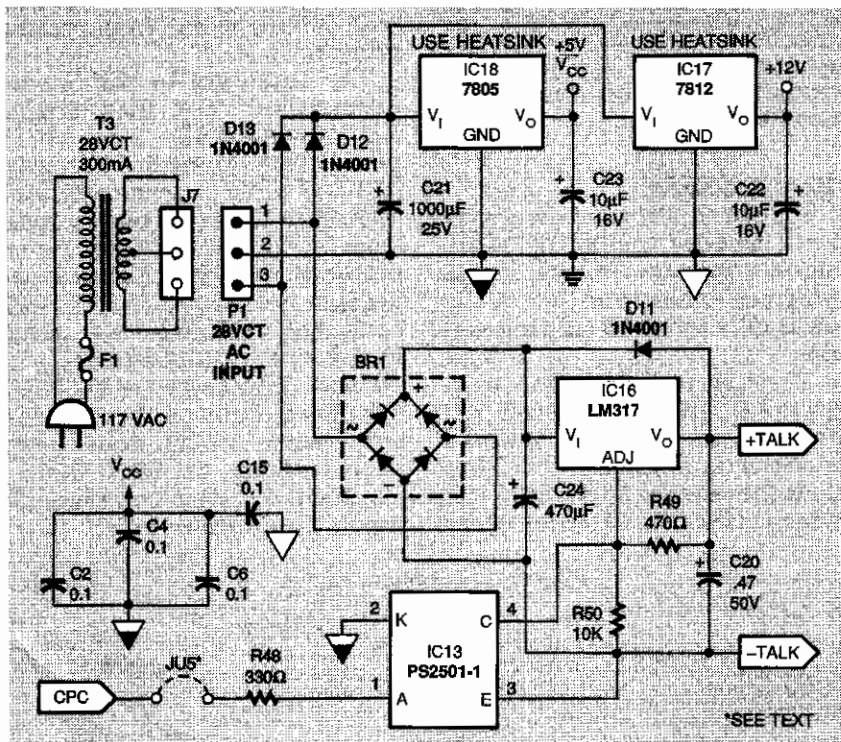


FIG. 8—A CONVENTIONAL POWER SUPPLY provides +5 and +12 volts DC. Note that IC16 can be turned off, thus disabling the talk circuit, if the input labeled CPC goes high. That happens under MCU control.

ORDERING INFORMATION

The following items are available from Digital Products Company, 134 Windstar Circle, Folsom, CA 95630, Voice: (916) 985-7219 Fax: (916) 985-8460. E-mail: DigProd@aol.com

KITS: Parts kit including printed circuit board, programmed microcontroller, relays, transformers, IC's, resistors, capacitors, documentation, etc., less enclosure: (\$199.95). Enclosure kit includes plastic case, drilled front panel, mounting screws, etc. (\$32.95). Hard-to-obtain IC's, including M-8870, M-991, ULN2003, 74HC14 (2), 74HC259, PS2501-1 (7): (\$31.25). Line transformers (T1, T2) and relays (RY1-RY6): (\$48.50), power transformer kit with T3 (120VAC only), fuse, AC cord: (\$14.75).

PARTS: Printed Circuit Board #PL6-001: (\$34.95). Programmed PIC16C57 (\$22.00). Complete documentation with schematic: (\$7.25). U.S. orders add \$8 S/H for Kits, or \$5 for Parts. Canadian orders add \$14 for Kits, \$9.50 for Parts. Write or fax for shipping information to other countries.

Prices shown in USA dollars. Remit U.S. funds only. CA residents add local sales tax. Money orders, checks, MasterCard, Visa, American Express, and Discover Card accepted. Personal and company checks require bank clearance before shipment and may delay orders 2-3 weeks. Prices and terms subject to change without notice.

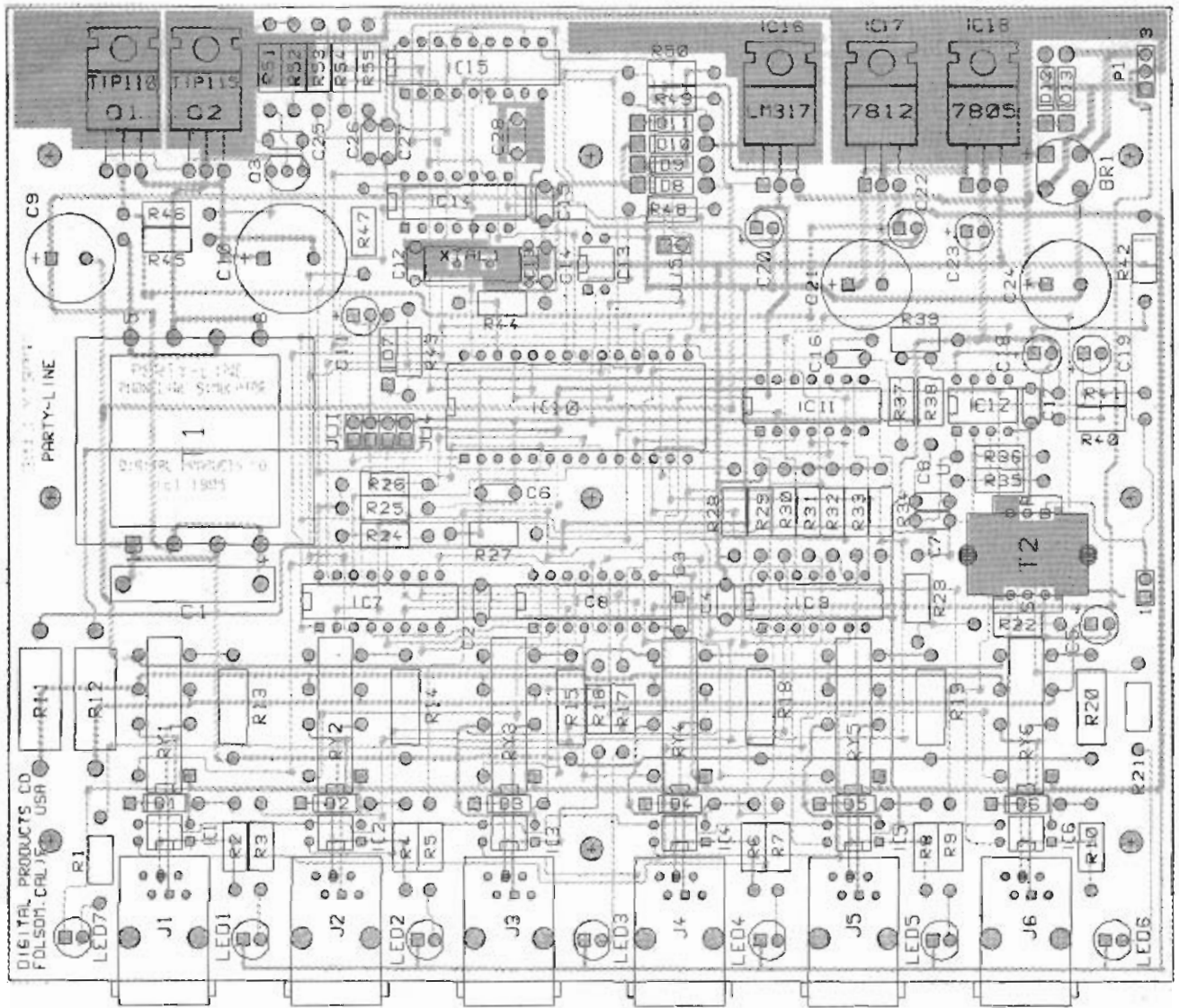


FIG. 9—PARTS PLACEMENT DIAGRAM: Mount all parts as shown here.

Call progress tones

The phone company considers sounds such as dial tone, busy, and ringing to be comfort tones that are present only to confirm the progress of the telephone call. Although foreign countries use similar tones, they often vary slightly from those heard in the U.S. Teltone's M-991 Call Progress Tone Generator (IC14) generates Party Line's call-progress tones. Table 9 lists several of the four-bit codes that the M-991 responds to. Some tones consist of a single, simple tone; others consists of several frequencies mixed together.

The M-991 makes generating the tones easy, but knowing when to generate them requires

some intelligence. For example, busy tone signals must be gated on and off on a periodic basis. The MCU disables the IC when necessary by setting the chip-enable line (pin 13) of IC14 high. Because the four-bit codes are latched at the falling edge of \overline{CE} , the MCU's RC0-RC3 lines can be freed immediately for use by the DTMF receiver or relay control. Party Line's task-based software handles all those time-sensitive operations.

CID filtering

The MCU-generated CID information initially appears in squarewave format, which is unacceptable as a Caller-ID signal. Hence it must be converted to a sine wave; doing so is the

job of active filter IC12-a. The op-amp is configured as a simple low-pass filter, with a roll-off frequency slightly higher than the highest frequency we need to send.

Although the filtered tones are not true sine waves—they look more like shark fins—they are quite acceptable to most Caller-ID products, which by design must be tolerant of signal anomalies, since in actual operation all phone lines introduce some noise and distortion.

Power supply

The power-supply schematic appears in Fig. 8. It contains three sections: two fixed-voltage 78xx regulators for powering the digital and analog circuits,

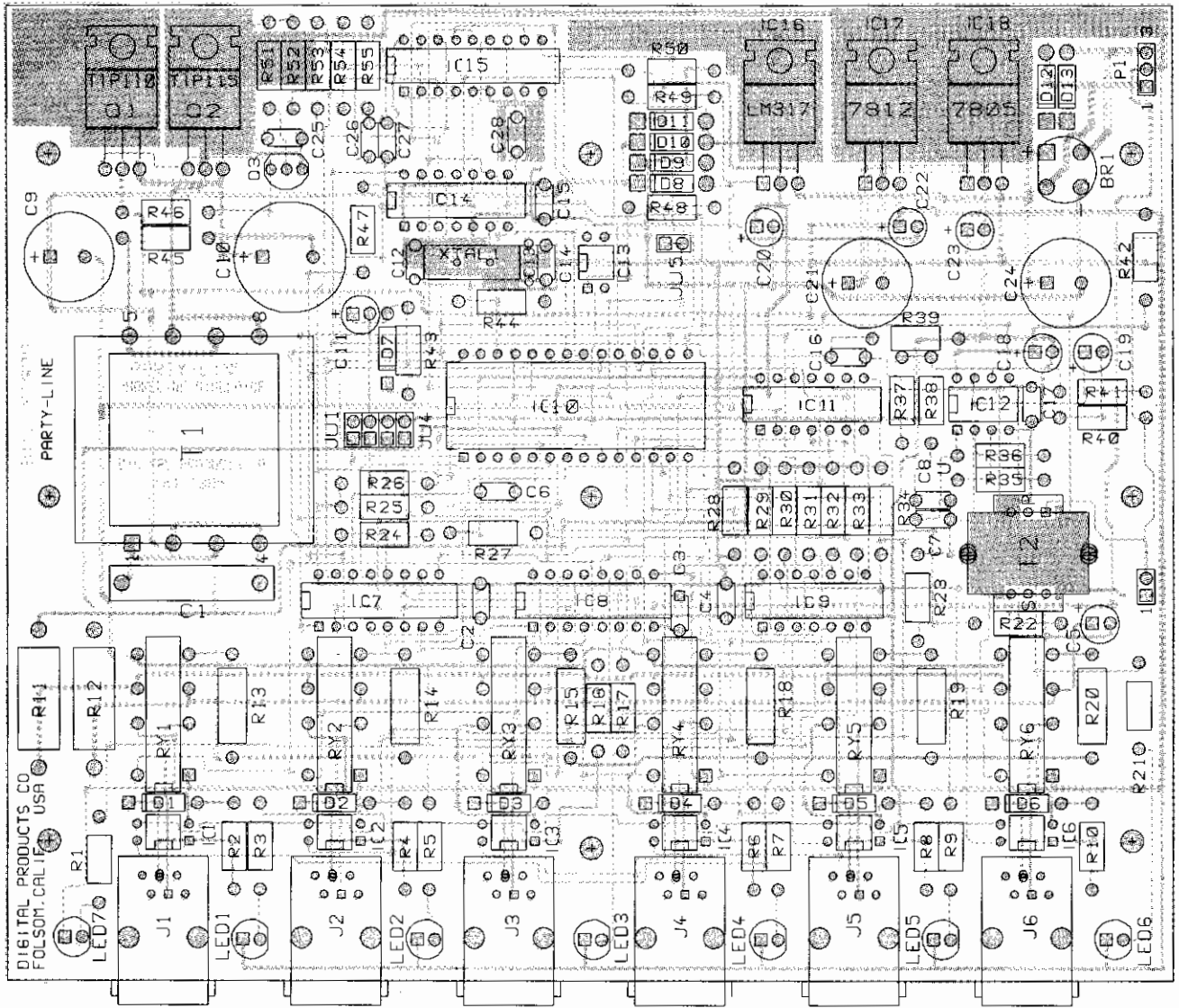


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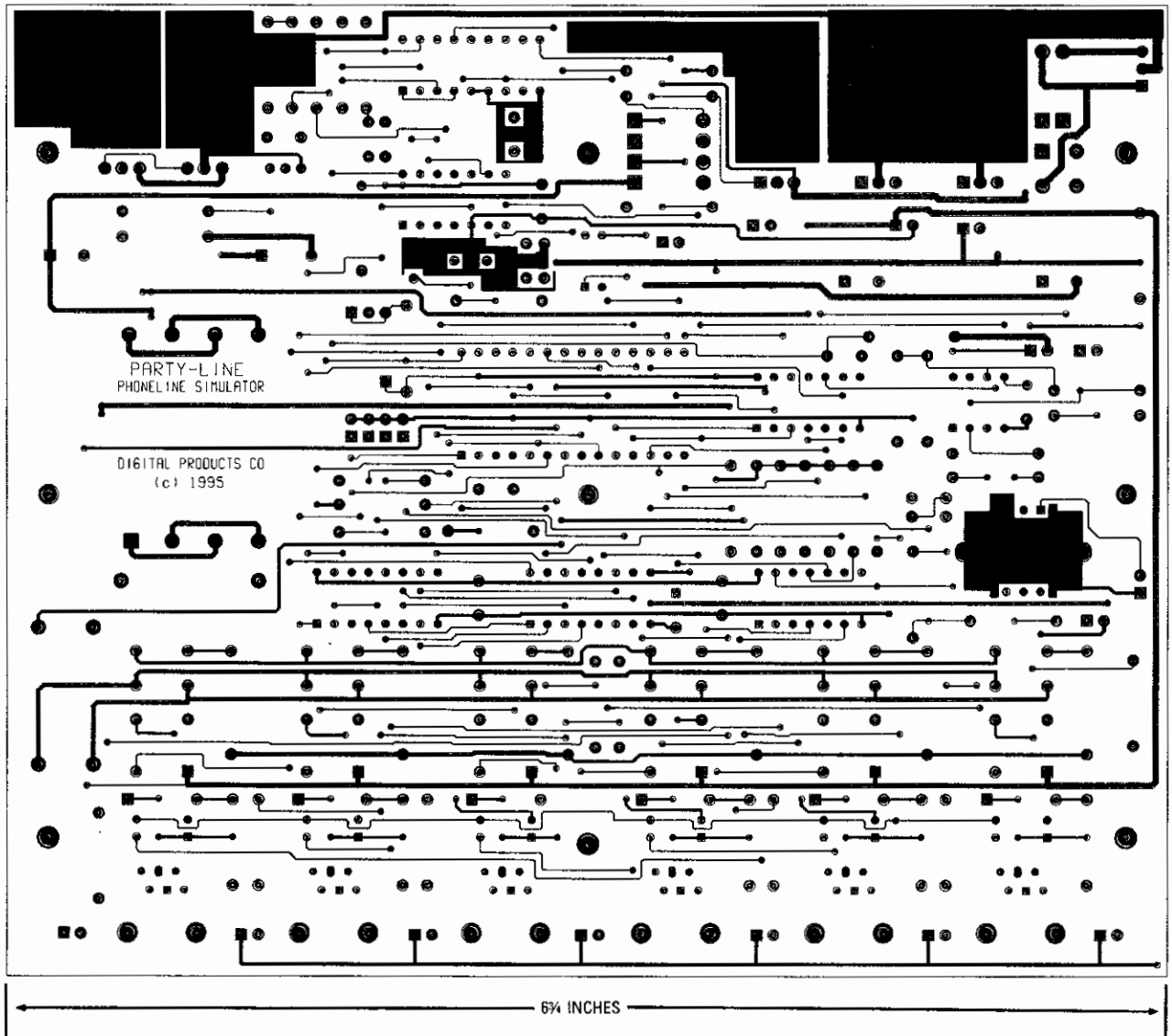
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PARTY LINE ARTWORK CIRCUIT-BOARD COMPONENT-SIDE.

and a variable regulator that creates the DC talk-circuit voltage.

The power supply centers around a 28-volt center-tapped transformer driving a full-wave bridge rectifier. Capacitor C21 provides bulk filtering of the raw DC, which is then applied to the 5- and 12-volt regulators, (IC18 and IC17, respectively).

The circuit requires only a few hundred milliamperes of current, so either 1/2-A or 1-A (78xx) regulators can be used. Because they are series-pass regulators, they run warm. You must use a heatsink on IC17 and IC18.

The phone line's DC power (+Talk and -Talk) is provided by an LM317 (IC16). Unlike 78xx

regulators, the output of the LM317 varies depending on the values of resistors R49 and R50. The chosen resistor values set the output to about 28 volts DC. The following formula determines the output voltage:

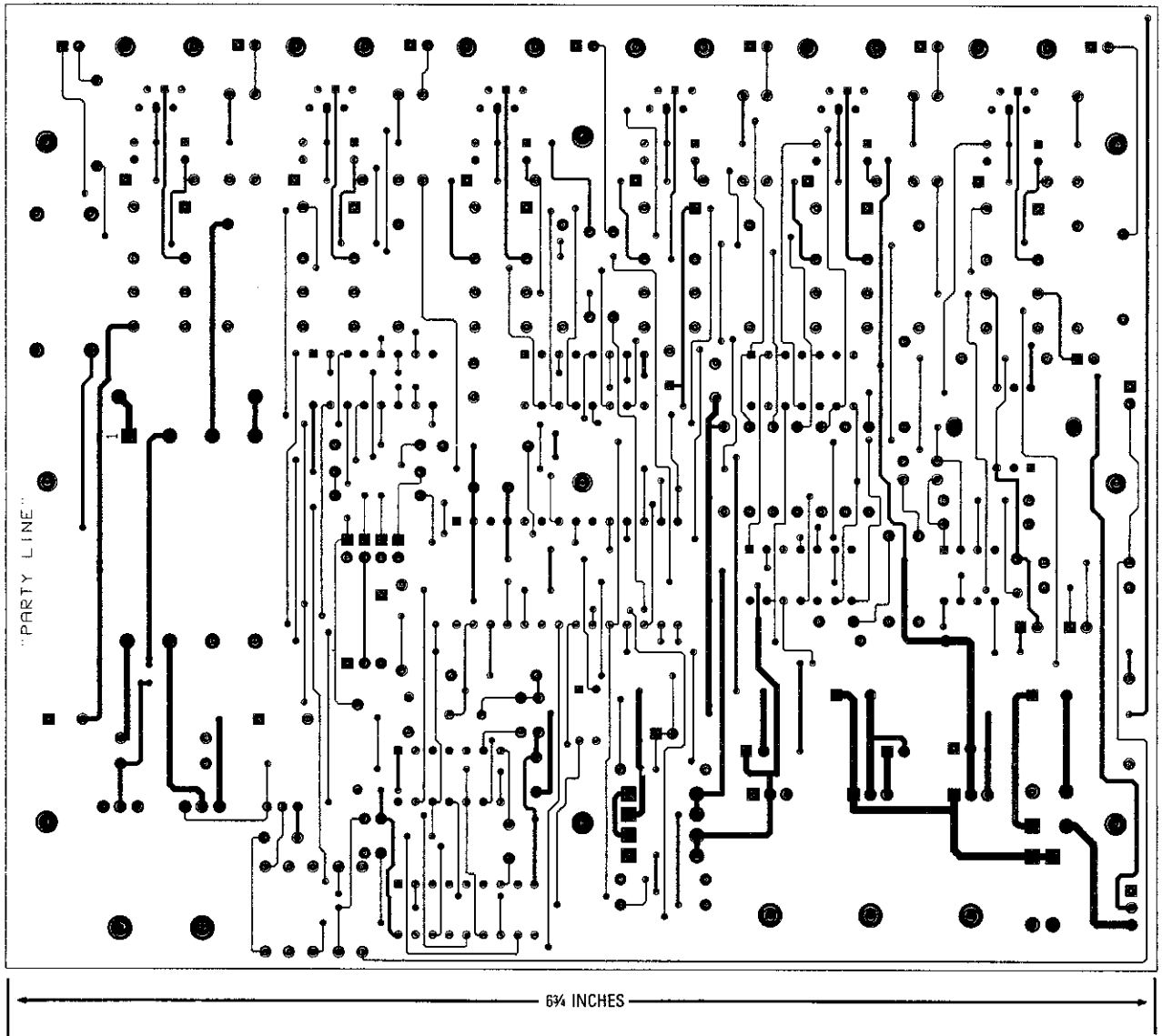
$$V_{OUT} = 1.25 \times (1 + R50/R49) + (0.000055 \times R50)$$

In our case, V_{OUT} works out to about 28.4 volts. Although most phone lines use a 48-volt talk voltage, our 28-volt supply is more than adequate. It should work correctly with all standard telephone equipment.

Notice that the regulator's ADJ terminal connects to optoisolator IC13. The latter may be used to shut off the voltage regulator during a CPC (calling

party control) pulse. The purpose of a CPC pulse is to help disconnect some telephone equipment. When a CPC pulse occurs, the phone voltage is interrupted for a few hundred milliseconds after the phone call ends. That interruption causes devices such as answering machines to disconnect immediately.

MCU port RC7 controls the CPC pulse. That port is normally low. To generate CPC, RC7 goes high for 500 milliseconds. That turns on optoisolator IC13, which shuts down voltage regulator IC16, leaving the talk circuit with a 1.2-volt bias condition, and that's low enough to simulate the CPC condition.



SOLDER SIDE PC-BOARD ARTWORK.

The CPC feature can be disabled by removing JU5, but it is unlikely that you would ever need to do so. (Actually, JU5 exists as a trace between two pads on the PC board.)

Construction notes

Due to circuit complexity, circuit sensitivity, and number of components, we recommend use of a PC board. Figure 9 shows the parts layout diagram. Party Line is a fun project to assemble, but it's not for beginners. If you don't have experience with CMOS ICs and circuit-board assembly, please practice on some simpler and easier circuits before attempting the project.

TABLE 10—CONFIGURATION SETTINGS

Jumper	Function	On	Off
JU1	Call block (*67)	Disabled	Enabled
JU2	Distinctive ring	Disabled	Enabled
JU3	CID name delivery	Disabled	Enabled
JU4	Caller ID	Disabled	Enabled
JU5	CPC	Enabled	Disabled

Use a 25–47-watt soldering iron; a temperature-controlled iron (set at 700–800°) works best. Do not use a soldering gun. Use only 60/40 rosin core solder. If you purchase a circuit board from the listed source, don't clean it, as it has a special tin-plate coating that prevents oxidation.

We recommend that you do

not substitute parts. Use the components shown in the Parts List, and only substitute those that you know are exact replacements. Capacitor voltage ratings are minimum recommended values; you can safely use units with higher voltage ratings. Use care in handling the ICs. They are CMOS devices that are sensitive to elec-

TABLE 11—SETTING TIME

Step	Description	Legal Values
1.	Enter time set command (#*)	#*
2.	Enter month (MM)	01-12
3.	Enter day (DD)	01-31
4.	Enter hour (hh)	00-23
5.	Enter minutes (mm)	00-59
6.	Enter exit command (*)	*

trostatic discharge, and can be damaged through mishandling.

Transformer T1 is a split-bobbin type with dual primaries and secondaries. This transformer is available from sources such as Microtran, Magnetek, Signal Transformer, and PREM Magnetics. Use of a standard power transformer is not recommended.

Transformer T3 can be either a wall- or chassis-mount type. Note that a 24-volt, center-tapped transformer will not operate Party Line correctly. If you use a chassis-mount device for T3, be sure to install a ½A fuse in the AC primary for protection. Although a power switch is not necessary, you can add an SPST toggle switch in series with T3's primary if desired. Be sure to thoroughly insulate any exposed high voltage wires! Also, do not apply power until all wiring has been inspected carefully.

Install the MCU (IC10) in a socket. Sockets for the other ICs are optional.

Transistors Q1 and Q2, as well as the three voltage regulators (IC16-IC18), should be anchored to the PC board with 4-40 machine screws and nuts. Install heatsinks on regulators IC18 (7812) and IC18 (7805). For best results, use a small amount of thermal grease (heatsink compound) with the regulators. Both IC17 and IC18 run warm.

Relays RY1-RY6 must be sensitive-coil types, and must not draw more than 20 milliamperes at 12-volts DC. Do not use a standard-coil relay.

Install a 4 × 2 pin, 0.1-inch male header block in the JU1-JU4 position. The PC board has a trace for JU5, the CPC control line. You can install a jumper block there if desired as well.

After assembly, be sure to trim any long component leads, and clean the solder flux off the board.

Mount the circuit board on short standoffs in an enclosure of your choice. If you are using a chassis-mounted transformer for T3, be sure to insulate it from the conductive surfaces of your cabinet! To avoid hum on the talk line, position T3 a minimum of two inches from T1 and T2.

Last steps

Table 10 outlines the settings for the four configuration jumpers (five counting JU5). To disable a function, simply remove the jumper. The only other step is to set time and date; Table 11 details the procedure. In brief, use a telephone at any station to enter the following: # * MM DD hh mm *. If you have successfully entered the time, you will receive a standard dial tone after pressing the final key. Incorrect time settings will result in a busy signal.

To test your Party Line, make a final check of the circuit board. Ensure that all parts are mounted with the correct orientation, and look for shorts, opens, and solder bridges on the PC board. Also, check the primary wiring to the power transformer.

You'll need two telephones to test the Party Line. Plug one phone into Station 1, and take the receiver off the hook. You should hear a dial tone, and the corresponding LED should light. Repeat the test for the remaining stations. Then plug in the other phone, and use one phone to call the other. Check that each station can dial out, and that each station can receive calls. Last, test the Distinctive Ring and Caller ID functions. Ω

VIDEO NEWS

continued from page 6

video-game hardware—are also working hard to produce games for personal computers.

Surf the Internet by TV

Long before HDTV—even this year—TV sets will take on more and more of the attributes of computers, just as many manufacturers are offering computers with TV boards. Sega and Philips have both developed add-ons to their video-game players that will provide Internet access for game-playing.

Thomson Consumer Electronics, the manufacturer of RCA TV sets, recently showed a prototype of a TV set that could be offered in the next two years. Using a standard 35-inch TV tube, the set has a built-in six-disc CD-ROM changer, a wireless QWERTY-type keyboard, 16 megabytes of memory, and a modem for Internet access. It's definitely not a computer—who needs a spreadsheet on the 35-inch TV in the living room? However, the manufacturer notes that CD-ROMs and Internet sites are increasingly offering entertainment that might be more appropriate for a family gathered around the TV than for an individual peering into a 14-inch computer screen. The company says that its TV sets are designed to offer all kinds of electronic entertainment, including those considered to be the province of computers. The company's picture-tube division is expected to start making tubes with finer pitch specifically for TV access to such computer functions. The higher-resolution tubes eventually will be necessary for HDTV images, as well.

An added note: In Japan, JVC is now offering a 16:9 widescreen-ratio TV set that can display TV and computer images simultaneously, presumably side-by-side. The 30-inch set uses signal-processing ICs to display interlaced and non-interlaced images at the same time. JVC predicts that in two years half of the widescreen TVs it sells will be directly computer compatible. EN