

Using Existing House Wiring for Computer Remote Control

PART 2

How to build a typical remote.

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LAST MONTH, we described the theory and construction of an Intelligent Remote Controller that utilizes a building's standard ac wiring for communicating between a computer and appliances. In this concluding part, we cover the details of a typical two-channel remote unit (sometimes called just a "remote") and

discuss some software to get the composite system "up and running."

The basic block diagram of a remote is shown in Fig. 1. Note that many sections of the remote resemble their counterparts in the controller because both devices can send and receive data over an ac power line.

How It Works. The user determines which remote he wishes to communicate with and what command he wishes to issue. For example, if he wants to toggle remote 41, a 233 must be outputted to the controller output port. The computer then executes the assembly language command OUT 5. (5 is the num-

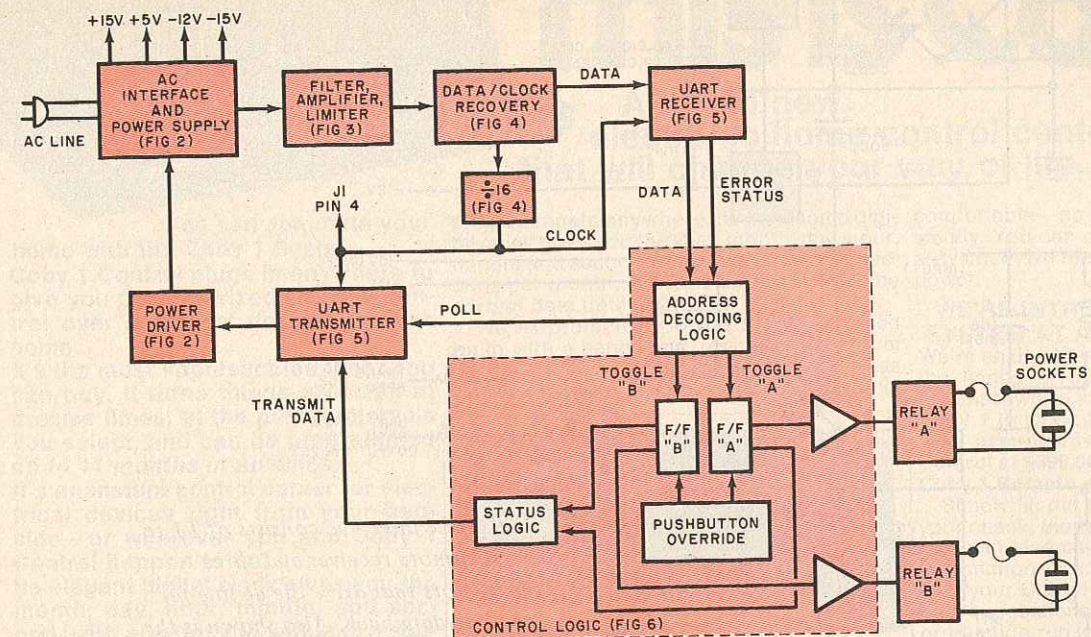


Fig. 1. Block diagram shows similarity of remote to last month's main controller.

ber of the output port while 233 is data.) The I/O port decoding logic on the controller board determines that the controller is being addressed with an output instruction. The controller UART transmitter then reads the data bus, formats the word, and sends it out to the power driver as a serial stream of data bits.

The power driver impresses the signal on the ac line via the ac interface adapter. The data appears on the ac line as a digitally modulated signal at about 50 kilohertz.

All the remotes are constantly monitoring the ac line for possible com-

mands. Each remote contains two independent channels, each capable of controlling one external device plugged into its power socket. This means that each remote is assigned two sequential addresses (selected by the user by putting jumpers on the remote board).

The signal received by the remote is coupled through an ac interface adapter tuned to 50 kHz. A high-pass filter (rolling off at 6 dB per octave below 20 kHz) removes the 60-Hz line frequency and all its relevant harmonics. The filtered output is amplified and used to drive a phase-locked loop (PLL). There, the vco

output from the loop is divided by 16 and used as the clock for the internal UART. The received data is recovered at the lock output of the PLL, and this signal is used as the input to the UART receiver.

When the receiver detects a data word, that word appears on its eight parallel output lines, along with error and flag information. The address and decode logic then determines whether or not that word is intended for that remote.

The three valid outputs from the address and decode logic are toggle-A, toggle-B, or poll. The latter is actually two commands—poll-A or poll-B—and the

PARTS LIST

C1, C2, C14, C15—0.1- μ F, 200-V capacitor
 C3—0.015- μ F capacitor
 C4, C5—0.001- μ F capacitor
 C6 through C10, C16, C17, C22 through C27, C34—0.1- μ F, 25-V capacitor
 C11—0.39- μ F capacitor
 C12, C18, C19, C28 through C33—0.01- μ F, 200-V capacitor
 C20, C21—470- μ F, 25-V electrolytic
 D1 through D5, D10, D11—1N4148
 D6 through D9—1N4001
 F1— $\frac{1}{4}$ -A fuse and holder
 F2, F3—5-A fuse and holder
 IC1—TR1602 UART
 IC2, IC3—4069 CMOS hex inverter
 IC4, IC8—4001 quad 2-input NOR gate
 IC5—4011 quad 2-input NAND gate
 IC6—74C107 dual JK flip-flop
 IC7—74C30 8-input NAND gate
 IC9—74LS93 4-bit binary counter
 IC10, IC11—NE535 op amp
 IC12—NE567 PLL tone decoder

K1, K2—Spdt, 5-A contact-rating relay (Stancor MS64-931 or similar)
 Q1, Q2, Q4—2N2907 transistor
 Q3, Q5, Q6, Q7—2N2222 transistor
 Following resistors are $\frac{1}{4}$ -watt, 5% unless otherwise noted:
 R1—15,000 ohms
 R2—3900 ohms
 R3, R13, R17, R18, R19, R23, R24—1000 ohms
 R4, R11—2200 ohms
 R5, R6—10,000 ohms
 R7, R8, R9, R20, R21, R22—3300 ohms
 R10—390 ohms
 R12—27,000 ohms
 R14—1800 ohms
 R15—1000-ohm, 10-turn trimmer potentiometer
 R16—10 ohms

R25—200 ohms
 R26, R28, R30—100,000 ohms
 R27, R29—270,000 ohms
 RV1, RV2,—V33MA1A varistor (GE)
 S ϕ S1—Spst normally open, pushbutton switch
 T1—Coupling transformer (see Note)
 T2—25-V CT 180-mA transformer
 VR1—7805 5-volt regulator
 VR2—79L12 -12-volt regulator
 Misc.—In-line fuseholders (3), 117-volt, chassis-mount ac sockets (2), line cord, suitable enclosure, mounting hardware, etc.
 Note: The following are available from Mountain Hardware, Inc., P.O. Box 1133, Ben Lomond, CA 95005 (Tel: 408-336-2495): T1 (MH-T1) for \$6.00; complete kit for one dual-channel remote including walnut case for \$99.
 Diodes are identified by letters "CR" and IC's by letter "U" in parts placement guide in Fig. 7.

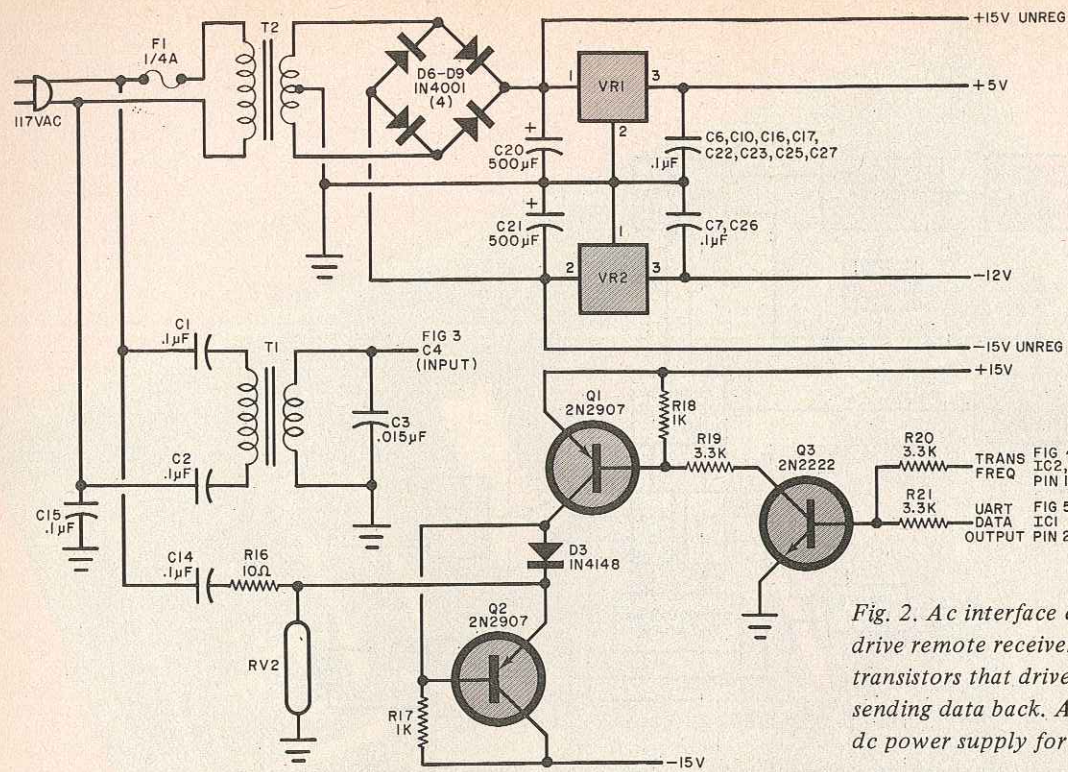


Fig. 2. Ac interface consists of T1 to drive remote receiver and three transistors that drive the ac line for sending data back. Also shown is the dc power supply for the remote.

status logic determines which of the two is acted upon.

A toggle command causes one of the two flip-flops to change states. This opens or closes a relay associated with that channel and controls the external device connected to that socket.

A poll command causes the status logic to place a word into the UART transmitter buffer in accordance with the following format. The first five bits of the data word contain the address of the remote channel being polled. The sixth bit contains the status of the remote device

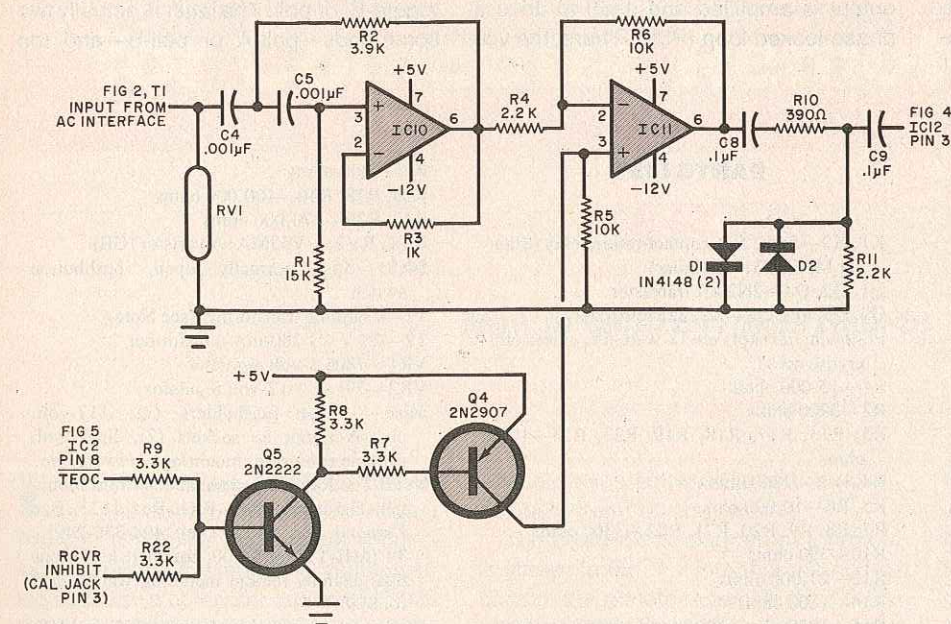
(on or off), while the seventh bit is set to zero to inform the system that a remote is responding to the controller. This indicates to all other remotes that the digital word on the ac line is not a command. The word is then formatted by the UART transmitter and sent via the ac interface to the power line.

AC Interface and Power Supply. This circuit (Fig. 2) forms the power supply to the electronic system and provides the interface between the digital receiver, the transmitter, and the ac line.

Transformer T2 and its associated components provide regulated +5 and -12 volts. Other components provide the unregulated ± 15 V required by the various circuits.

Transformer T1, resonant at 50 kHz, provides the actual interface and isolation from the ac line.

Filter, Amplifier, Limiter. This circuit (Fig. 3) operates in exactly the same way as its companion circuit in the controller described last month. See the December issue for details.



Next month, Part 3 will conclude this article with the final circuit discussions, construction and software.



This is Coby 1.™

A brand new electronic home control center that will change your way of life.

- You can automate your home with the Coby 1 System.
- Coby 1 Control plugs in anywhere to give you computerized ON/OFF control over electrical devices in your home.
- It's the most sophisticated timer you can buy. It turns things on or off at precise times, at the preset intervals you select, and can be programmed up to 11 months in advance.
- It's an instant control center for electrical devices right from your bedside—or wherever you and Coby 1 Control happen to be.
- Its elegant digital clock gives you the month, day, hour, minute, and second, with accuracy to within five seconds per month.

COBY 1 CONTROL NEEDS NO WIRING—PLUGS IN ANYWHERE.

The compact control panel, which we call Coby 1 Control, plugs into any ordinary wall outlet, sending computer-coded pulses through your present wiring.

The pulses trigger Coby 1 Remotes—small remote switches to go between plug-in appliances and wall sockets. Soon (by March) we will also have Coby 1 Remotes to replace wall switches and Coby 1 Remotes to take care of built-in appliances like water heaters and air conditioners. It's safe, simple, and sure. There's nothing like it.

A REMARKABLE APPLICATION BREAKTHROUGH IN MICROELECTRONICS AND PULSE-CODE COMMUNICATION.

The Coby 1 System™ is the result of brilliant engineering by a team of aerospace electronics people. Coby 1 Control includes an Intel 8085 Microprocessor—a complete tiny computer—plus control circuitry, power supply electronics, coding and signal-generating circuits, an emergency power cell, and memory. The memory contains 2048 words of low-power, programmable random access memory (RAM) and 2048 bytes of read-only memory (ROM). It stores device numbers, commands, and status information for up to one hundred Coby 1 Remotes.

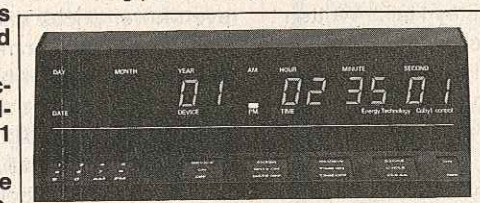
The coding and signal-generating hardware translates commands and distributes them through your home wiring (but without interfering with any of your other appliances) to the Coby 1 Remotes, which decode the signals and turn things ON or OFF.

As you enter commands through the keyboard, the display lights up to confirm. It can also be used to review commands stored in memory. All programs are entered, stored, and modified through 12 function and control keys and a 10-key numeric pad (plus AM and PM keys).

ITS ACCURACY IS BLACKOUT-PROOF. Power blackout? Built-in battery power keeps Coby 1's memory fresh. Unlike a conventional timer or clock radio, Coby 1's clock won't lose a second. When power comes back on, the batteries automatically recharge. This feature also lets you unplug your control unit and

plug it in again anywhere. Its handsome digital clock gives you the year, month, day, hour, minute and second with accuracy to five seconds per month. The calendar will show the correct date until 2021.

We've protected Coby 1's sophisticated brain with a handsome, precision-aluminum package that is spillproof. Since Coby 1 has no moving parts, it requires no maintenance.



IT'S FUN TO USE COBY 1.

Each Coby 1 Remote is assigned an identification number. If the front hall lamp is Number One, you simply tell Coby 1 Control to turn Number One on or off—now, Tuesday, any day or every day, if you like. And if you've ever operated a pocket calculator, you'll have no problem whatsoever with Coby 1.

COBY 1 IS AMONG THE GREATEST LUXURIES YOU CAN OWN. Picture yourself on a frigid winter morning. Coby 1 can wake you with your hi-fi system and a lamp.

You rise to a warm bathroom. When you come out, the coffee is ready to pour. Coby 1 turns the hi-fi off and the TV on, while you enjoy your coffee and paper.

Coby 1 has warmed the car engine for you, so it starts readily and warms up quickly. At bedtime, with Coby Control now plugged in at bedside, you turn off all the lights and switch off the TV—without getting up. You go to sleep knowing things will be ready for you again in the morning. If, during the night, you want to turn on the outside or living room light, you have the comfort and security of being able to do so from your bedside table.

IT'S A CARETAKER WHEN YOU'RE GONE.

Now you can go away for a week (or a month) and leave Coby 1 in charge. Consider a potential thief watching your house: lights (Nos. 1-6) go on and off as if people were moving around. The TV (No. 7) goes on; then goes off. Finally, the bathroom (No. 8) and bedroom lights (No. 9) go out. You can repeat the pattern daily or vary it for up to a year in cycles as short as a second or as long as 100 hours. Yet it will use less energy and suggest more activity than leaving lights or a radio on constantly.

When you come home, Coby 1 can have the house warm (or cool, in summer), the porch light on, the sofa lamp on, and the hi-fi on to welcome you.

CONSIDER THE ENERGY SHORTAGE. Coby 1 can do wonders for your electrical bill. It never forgets to turn things off. It can turn car heaters, air conditioners, or electric heaters on just far enough ahead to make things

comfortable—no need to have them on constantly. You can change the times from your easy chair. No mechanical timers; no wasted power.

WE'RE INTRODUCING THE COBY 1 SYSTEM AT A SPECIAL LOW PRICE.

We're anxious to get the first factory run into the hands of users as quickly as we can because we're interested in how you put Coby 1 to work. So until February 15, 1978, we'll accept advance orders for a Coby 1 Control at \$399.00, the price to include a free Coby 1 Remote. Other remotes will be extra.

Simply fill out the coupon and send it with your check, money order, or credit card data. You can also call in your order or get more information by calling (505) 526-3358. We'll ship your Coby 1 along with full instructions and suggestions on its use, after our first production run in January. We'll also include our 90-day parts-and-labor limited warranty.

WHO ENERGY TECHNOLOGY IS:

The company was started by the three of us, Brook Reece, Phil Reed, and Keith Burn. We developed the system ourselves. We're excited about Coby 1 because everyone we've talked to has expressed real interest in the product and sees a need for it.

We've been working on Coby 1 for months. Development and testing of production models is now complete. They'll be ready to ship in January.

Dealer inquiries invited. Energy Technology, Incorporated, 1601 South Main St., P.O. Box Q, Las Cruces, NM 88001. Phone: (505) 526-3358.



Mail to:

Energy Technology, Inc.

1601 South Main St., P.O. Box Q, Las Cruces, NM 88001
Put me down for one of the first Coby 1's. I understand that this is an advance order, and that shipment is expected after January 15, 1978.

Ship me one Coby 1 Control and one 10-amp plug-in Coby 1 Remote at the Special Introductory Price of \$399.00, shipping included. \$399.00

In addition, I want to order the following:
 _____ more 10-amp plug-in Coby 1 Remotes @ \$39.95
 _____ 25-amp plug-in Coby 1 Remotes @ \$49.95
 Total _____

New Mexico residents: please add Gross Receipt tax
 Check BA/V Money Order MC Total _____

Card No.: _____ Card Exp. date _____

Interbank No. _____ Ship to _____

Address _____

City _____ State _____ Zip _____

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Signature _____