HARDWARE HACKER

Focused X-ray breakthrough, C-60 and the new Buckyballs, electric power research info, getting telephone information, and caller number delivery secrets.

DON LANCASTER

Let us start off with a few updates to the infrared people detectors we looked into a column or two ago. It seems *Amperex/Phillips* decided to jump ship and abandon their line of IR detectors. Their great ap notes seem to have been discontinued. Several remaining pyroelectric detector chip samples are supposed to still be available through their sales support line (401-762-3800).

On the other hand, people detectors have suddenly become a low-cost commodity. So much so that it is now usually cheaper to buy retail and modify, rather than building your own motion sensor up from scratch. Especially when you factor in the critical *Fresnel* lens design. One cause for the sudden price drop is a new California law which mandates these on nearly every light switch in new office building construction.

Herbach and Rademan offers a great ready-to-install infrared people detector as #TM90SE1491 for $12.50. And the *Heathkit* folks have several new occupancy and intrusion detector variations in their free home-security electronics catalog. Or, you might also want to check your local price club or warehouse builder's supply outlet.

A reminder that we have a great help line available for tech questions, off-the-wall networking, and useful consultant referrals. All per the box below. And please remember that we are using California time during the summer. Those 4:30 AM calls tend to get just a tad old. And please, please *carefully* read the *entire* column, especially the *Names and Numbers* sidebar.

Oh yeah—please note the French mathematician's name is "Fre'-nell," not "fresh-nell." And, of course, the correct pronunciations found on our ongoing voice helpline are "hee-lah" and "ten-ah-hah."

Our biggie for this month involves telephone caller identification chips and standards. But, first, let's find out how you go about...

Getting telephone information

Contrary to popular belief, it's real easy to get full technical details on nearly everything that involves the telephone company. All you have to do is ask them.

There is a great publication known as the *Bell System Technical Journal* that has been around for over 60 years now. Included are full details on just about everything involving telephone hardware and software. Check almost any large technical library for your access. There's also the *Bell System Record,* but it focuses more on nontechnical policy issues.

For ongoing telephone standards and tutorial information, start out with the no-charge *Bellcore 1991 Catalog of Technical Information.* Then order the individual papers you want. These do tend to be a tad on the pricey side, with $20 to $90 being typical. VISA orders are accepted with one-week delivery. Sorry, but I don't know of any library that has a full set of these to loan out. Please let me know if you find a lower-cost access source. The library obviously screams to be made available on CD ROM.

Caller number delivery

Most of your telephone operating companies are now in the midst of upgrading to a totally digital system that includes a number of new CLASS services. By far the most popular new service is known as *Caller Number Delivery,* which can show you who is calling you before you pick up your telephone handset.

Caller number delivery does appear rather controversial. But, for most people most of the time, knowing who is calling you is infinitely more important than protecting people's "rights" to make undetected obscene phone calls. Very sadly, at least one state (Pennsylvania) has stupidly banned this wonderful new service. In other areas, the caller is given the option of blocking their caller ID, for those one-in-a-thousand calls when your anomynity might legitimately be desired. Maybe for a drug overdose hotline. Blocking can get done by entering a three-digit code before you make your call.

So what is caller ID, and how does it work?

Figure 1 shows you some of the more interesting Bellcore documents that involve caller ID. But the key horse's-mouth paper you'll need is Technical Reference TR-TSY-00030 and titles *SPCS Customer Premises Equipment Data Interface.* The cost is $25 via VISA.

Figure 2 shows you the exact placement of the tone codes. Caller number delivery is normally provided as a code burst between the first and second *full* rings while your phone is still on its hook. Enough delay is provided to allow for the short half-second breaks sometimes involved in selective ringing.

After your first full ring gets detected, a data path is established. A data path is simply any method of receiving some modem tones. The ID tones are then routed to suitable circuitry to recognize the data burst and strip out the needed information. The format and codes are related to the digital codes used in pagers.

The tones sent out are plain old serial binary modem tones at 1200 baud. A digital logic one (or a *mark*) is defined as one cycle of a 1200-Hz sine wave. A digital logic zero (or a

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Phone or write your **Hardware Hacker** questions directly to:

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space) is defined as nearly two cycles of a 2200-Hz sine wave. Each eight-bit character is preceded by a space start bit and a mark stop bit.

The transmitted signal level is −13.5 dBm. While the code transmission is asynchronous, phase coherence is preserved throughout the entire caller ID message. No more than 20 marks are permitted between characters.

Figure 3 shows you the data format. It might appear fairly complicated at first, but making sure the number is valid is quite important. Almost certainly, you will elect to use a computer, or at the very least, some simple microcontroller in your caller-ID display circuitry.

The first thing sent is called the *channel seizure signal.* That consists of 30 bytes of a Hex $55 code. After decoding, another way to look at this "hey wake up!" signal is one quarter second of a 600-Hz square wave.

After the channel seizure signal, a carrier signal is sent. It's used to condition your receiver for valid data. The carrier consists of at least 150 milliseconds worth of marks. After the decoding, you have a one-sixth second

1. NYNEX Catalog of Technical Information, #NIP-7400, Free.
2. SPCS Customer Premises Equipment Data Interface, #TR-TSY-0030, $25.
3. CLASS Feature: Calling Number Delivery #FSD-02-1051, $30.
4. CLASS Feature: Calling Number Delivery Blocking #TR-TSY-000391, $33

The main Bellcore service number is (800) 521-CORE.
Of these resources, (2) is by far the most important.

FIG. 1—HERE'S THE KEY INSIDER SECRET PAPERS involved with telephone system caller number delivery.

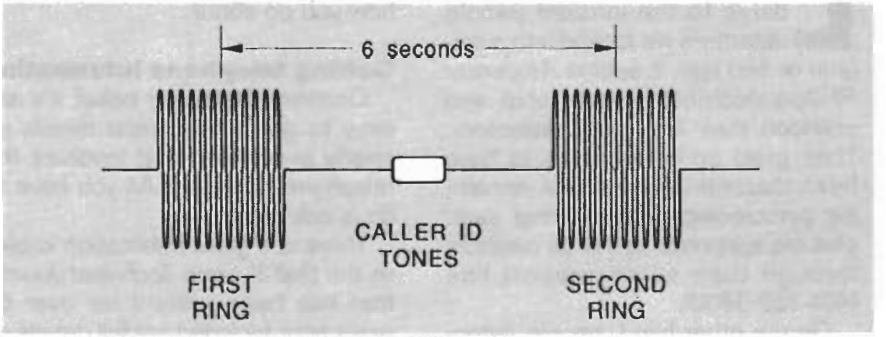

FIG. 2—THE CALLER ID DATA BURST is sent between the first and second rings as shown. The transmitted level is −13 dBm and enough delay is provided to allow for distinctive ringing patterns. A typical number ID will take half a second. The phone must remain on hook while the ID is being received.

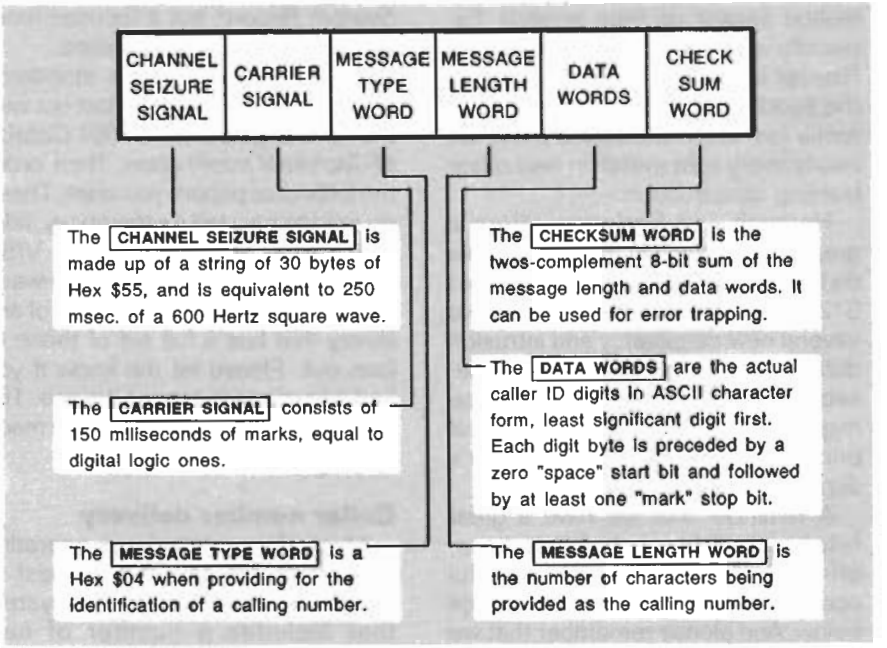

FIG. 3—THE DATA FORMAT for the caller ID service.

solid string of logical ones following your quarter-second burst square wave at 600 Hz.

Your caller-ID receiver circuitry is supposed to use this "wake up call" and string of marks to prepare itself for valid data reception. After setup, the first valid data byte is called a *message type word.* If that burst is for the caller number delivery, your message type word will be a hex $04. Other codes could get used for other purposes. For instance, a hex $0A means "message waiting" for pager applications.

The next byte is called the *message length word* that tells you how many digits are to be provided in the caller ID numbers that are to follow. The message length does *not* include itself or the checksum in its count.

The actual ASCII characters for the caller phone number follow, starting

NAMES AND NUMBERS

Bellcore
445 South Street, Room 2J-125
Morristown, NJ 07926
(201) 829-4785
CIRCLE 301 ON FREE INFORMATION CARD

Communications Specialists
426 West Taft Avenue
Orange, CA 92665
(800) 854-0547
CIRCLE 302 ON FREE INFORMATION CARD

Dialog Information Services
3460 Hillview Avenue
Palo Alto, CA 94304
(415) 858-2700
CIRCLE 303 ON FREE INFORMATION CARD

Electric Power Research Ins.
3412 Hillview Avenue
Palo Alto, CA 94304
(415) 855-2000
CIRCLE 304 ON FREE INFORMATION CARD

GEnie
401 North Washington Street
Rockville, MD 20850
(800) 638-9636
CIRCLE 305 ON FREE INFORMATION CARD

Herbach & Rademan
401 East Erie Avenue
Philadelphia, PA 19134
(215) 426-1700
CIRCLE 306 ON FREE INFORMATION CARD

Materials & Electrochem Res.
7960 South Kolb Road
Tucson, AZ 85706
(602) 574-1980
CIRCLE 307 ON FREE INFORMATION CARD

Meridian Data
5615 Scotts Valley Drive
Scotts Valley, CA 95066
(408) 438-3100
CIRCLE 308 ON FREE INFORMATION CARD

Mouser Electronics
11433 Woodside Avenue
Santee, CA 92071
(800) 346-6873
CIRCLE 309 ON FREE INFORMATION CARD

National Semiconductor
475 Ellis Street
Mountain View, CA 94043
(213) 323-3923
CIRCLE 310 ON FREE INFORMATION CARD

Power Quality
2742 Eastman Avenue #33-34
Ventura, CA 93003
(805) 650-7070
CIRCLE 311 ON FREE INFORMATION CARD

Satco
924 South 19th Avenue
Minneapolis, MN 55404
(800) 328-4644
CIRCLE 312 ON FREE INFORMATION CARD

SGS-Thomson
100 East Bell Road
Pheonix, AZ 85022
(602) 867-6259
CIRCLE 313 ON FREE INFORMATION CARD

Sierra Semiconductor
2075 North Capitol Avenue
San Jose, CA 95132
(408) 263-9300
CIRCLE 314 ON FREE INFORMATION CARD

Synergetics
Box 809-RE
Thatcher, AZ 85552
(602) 428-4073
CIRCLE 315 ON FREE INFORMATION CARD

VSI Telecommunications
9329 Douglas Drive
Riverside, CA 92503
(800) 999-8232
CIRCLE 316 ON FREE INFORMATION CARD

with the least significant digit. For instance, a digit "2" should get ASCII coded as hex $32.

Your message ends with a *checksum word* used for optional error detection. The checksum is the two's complement of the 8-bit sum of the message type word, your message length word, and the number of data words provided. To provide an error detection, you run your own 8-bit sum of all the bits of all the data words, and then add the checksum to it. If there are no transmission or reception errors, you should get a zero result. A non-zero result means an irrecoverable error.

I've just described the *single data message format* to you. Some nasty complications can arise if you have multiple data messages or several CLASS services active, such as call waiting. See the Bellcore info for further details.

There are a number of caller ID devices commercially available, with pricing in the $60 to $500 range. Typical are the *Allied incoming call identifier*, the *Bellsouth calling line identifier*, the *Cidco Slimline* series, and the TC-1021, TC-1080, and the TC-1082. One discount source of all these is *VSI Telecommunications*.

Do note that your caller number delivery service must be provided to you before you can use any of these devices. If the code is not being sent, there is no way you can receive it. There might be certain state laws prohibiting their use as well. That, of course, can be cured by staking your state representative to the nearest anthill. Finally, anything you connect to the telephone line has to be FCC Type 68 approved. Meeting the rules for type approval is fairly reasonable and simple. But the approval process itself is a bear.

We do have several experimental caller ID projects in the works here at **Radio-Electronics**, along with some simulator and test software. But there are ongoing problems with service availability, with meeting FCC part 68 specs, and in keeping the price low enough. Probably some absolute minimum general purpose caller ID interface kit that *demands* use of a personal computer programmed in machine language to develop your own circuits makes the most sense at this time. Let us know what you want to see here.

A caller-ID chip

As Fig. 4 shows us, there are usually four stages to the caller ID receiver. The first stage is called an *FCC Part 68 Interface*. That is needed to safely and legally connect to your phone system. Full details on Type-68 interface secrets appear in the *Hardware Hacker II* reprints.

The second stage is the *analog front end*. The analog front end provides filtering and amplification, and converts all of your tones into actual TTL ones and zeros.

Figure 5 shows you an analog front-end circuit that uses the brand new *Sierra Semiconductor* SC11211N caller-ID chip. You input the low-level telephone tones and get out a serial data stream ready for computer or microcontroller interpretation. Inside the chip is a fancy filter, an energy detector, a tone demodulator, and a clock. An ordinary TV color crystal

and four capacitors is all you need to use this circuit. Cost for the 16-pin mini DIP is in the $4 range in small quantities.

There's also a fancier SC11210 chip fabricated in a smaller package that deletes the internal crystal oscillator, the level setting, and all of the energy-detection features. Sierra also has ap notes on suitable FCC part-68 interfaces.

While these chips are low in cost and work rather well, note that they are *only* analog front ends. "All" they do is reliably accept low-level tones from the part 68 interface and then convert them into a string of digital ones and zeros.

The third ID stage is the *number extractor*. The number extractor takes the serial data stream, makes sure it's valid, and then extracts and formats the calling number. The number might also be displayed. The number extractor almost has to be a computer or microcontroller, since it probably would be unbearably complicated and expensive otherwise.

The final and optional stage is any "gee whiz" stuff. Things like looking up the actual name of the caller. Or pulling their sales or service records. Or keeping a full record of the last hundred calls. Or interacting with a humongous CD-ROM data base. Once again, be sure to let us know what you want to see in the way of further caller-ID projects.

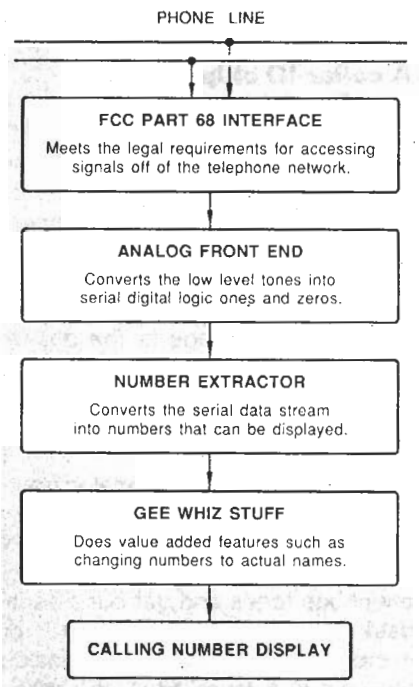

FIG. 4—THE FOUR STAGES INVOLVED in a calling number ID display.

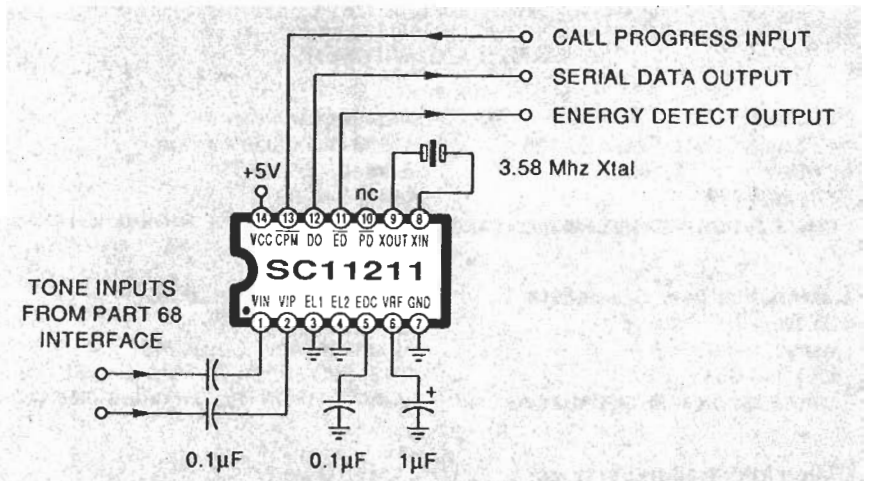

FIG. 5—A CALLER ID ANALOG FRONT END that uses the Sierra Semiconductor SC1121 chip. Low-level tones are accepted from the FCC Part 68 interface and get converted into serial ones and zeros for further digital processing.