Don Lancaster's

Hardware Hacker

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Let us start off with several 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 remain available through their (401) 762-3800 sales support line.

On the other hand, people detectors have instantly 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 big 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 and 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 a 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. US callers only, please. 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 "Fern-ell", not "fresh-nell." And, of course, those 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 is 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 most any large technical library for your access. There's also the *Bell System Record*, but this one is nontechnical.

For ongoing telephone standards and tutorial info, 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 or loans them out.

Caller Number Delivery Secrets

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 your "right" 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 one shows you some of the more interesting Bellcore documents which involve caller id. But the key horses-mouth paper you'll need is Technical Reference TR-TSY-00030 and titled *SPCS Customer Premises Equipment Data Interface*. The cost is $25 via VISA.

Figure two 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 gets 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 will then get routed to suitable circuitry to recognize the data burst and strip out the needed information. The format and codes are related to

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.
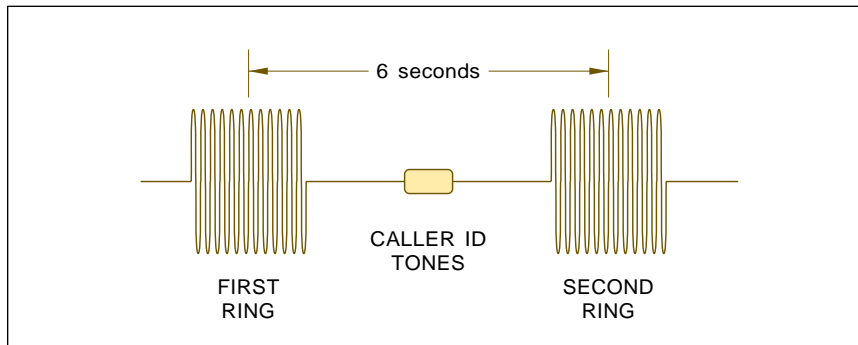
6 seconds

CALLER ID
TONES

FIRST
RING

SECOND
RING

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.

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 Hertz sinewave. A digital logic zero (or a *space*) is defined as nearly two cycles of a 2200 Hertz sinewave. Each eight bit character is preceeded 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 three shows you the data format. Which 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*. This 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 hertz square wave.

After the channel seizure signal, a carrier signal is sent. This is used to condition your receiver for valid data. This carrier consists of at least 150 milliseconds worth of marks. After the decoding, you have a one-sixth second solid string of logical ones following your quarter second burst

squarewave at 600 Hertz.

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 this 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* and tells you how many digits are to be provided in the caller id numbers that are to follow. This message length does *not* include itself or the checksum in its count.

The actual ASCII characters for the caller phone number follow, starting with the least significant digit. For instance, a digit "2" should get ASCII coded as hex $32.

Your message ends with a *check sum word* used for an 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 check sum 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 papers.

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. This, of course, can be cured by staking your

| CHANNEL SIEZURE SIGNAL | CARRIER SIGNAL | MESSAGE TYPE WORD | MESSAGE LENGTH WORD | DATA WORDS | CHECK SUM WORD |

The **CHANNEL SIEZURE SIGNAL** is made up of a string of 30 bytes of Hex $55, and is equivalent to 250 msec. of a 600 Hertz square wave.

The **CARRIER SIGNAL** consists of 150 mlliseconds of marks, equal to digital logic ones.

The **MESSAGE TYPE WORD** is a Hex $04 when providing for the identification of a calling number.

The **CHECKSUM WORD** is the twos-complement 8-bit sum of the message length and data words. It can be used for error trapping.

The **DATA WORDS** are the actual caller id digits in ASCII character form, least significant digit first. Each digit byte is preceeded by a zero "space" start bit and followed by at least one "mark" stop bit.

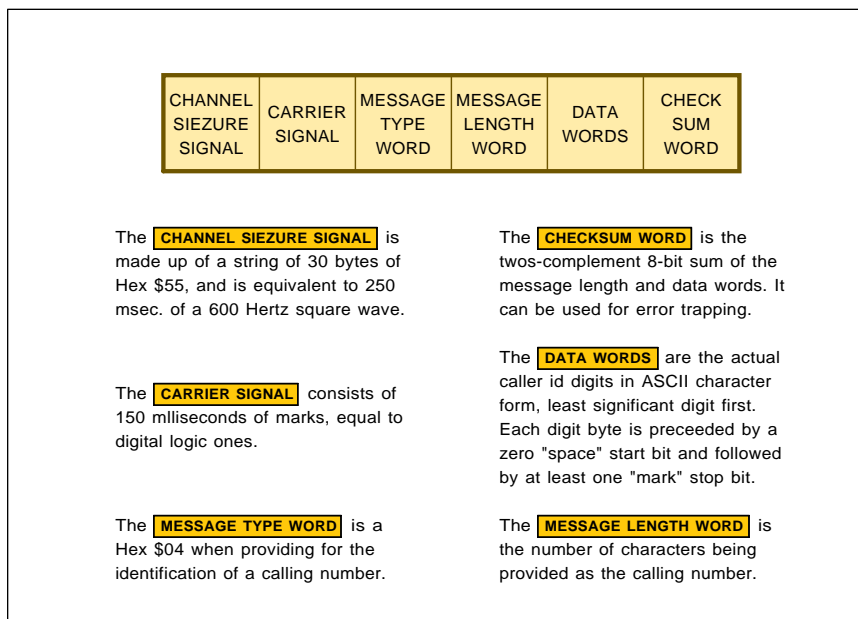The **MESSAGE LENGTH WORD** is the number of characters being provided as the calling number.

Fig. 3 – THE DATA FORMAT for the caller id service.

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.

A Caller ID Chip

As figure four shows us, there are usually four stages to the caller id receiver. The first stage is called a *FCC Part 68 Interface*. This one 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 forms the *analog front end*. The analog front end can provide filtering and amplification, and then converts all your tones into actual TTL ones and zeros.

Figure five 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 your computer or a microcontroller interpretation. Inside the chip is a fancy filter, an energy detector, a tone demodulator, and the clock. An ordinary tv color crystal and four capacitors is all you need to use this circuit. Cost for this 16-pin minidip is in the $4 range.

There's also a fancier SC11210 chip in a smaller package that deletes the internal crystal oscillator, all the level setting, and 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
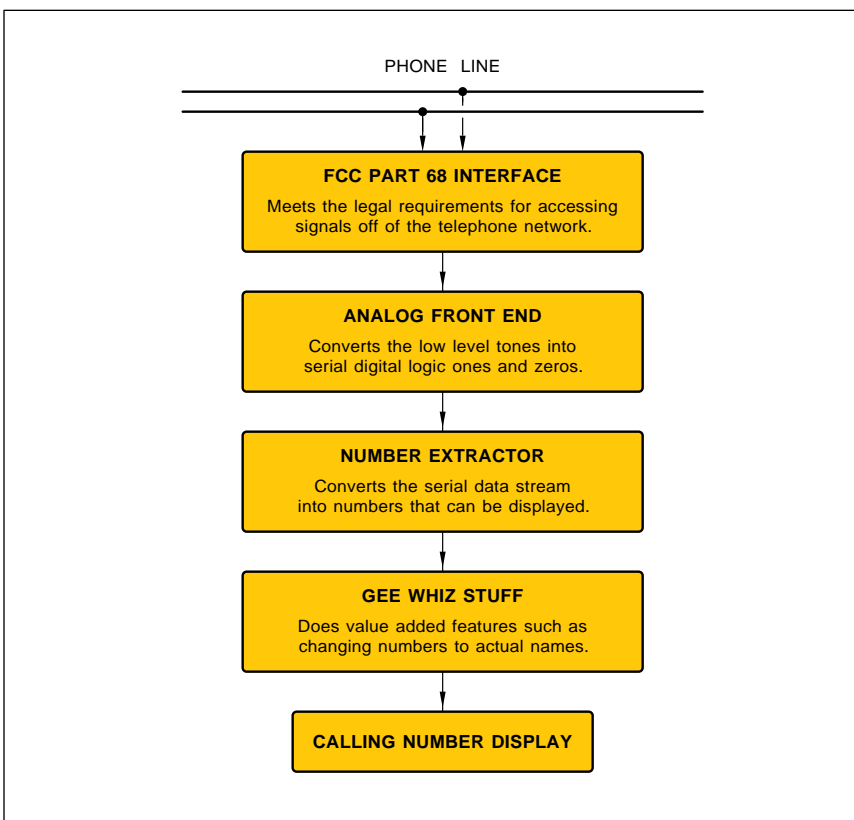

Fig. 4 – THE FOUR STAGES INVOLVED in a calling number id display.

ones and zeros.

The third id stage is the *number extractor*. The number extractor can take your serial data stream, makes sure it is valid, and then extracts and formats your calling number. This 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 humongus 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.

Buckyballs and C60

Carbon is one of the more interesting chemical elements. It forms the basis of all life as we know it. And, because of some energy and bonding restrictions, carbon quite possibly will also turn out to be the basis of all life as we don't know it. Carbon is also the key to most fuels, plastics, and foods. It bonds readily with many other elements, creating by far the richest assortment of useful chemical compounds.

Until recently, there were only two known forms for any pure carbon molecules. These were the supersoft graphite and superhard diamond. But several chemists (Kroto, et al. *Nature* v318 p162 (1985)) have discovered a uniquely bizarre third form of carbon molecule. By taking 20 hexagonal groupings of six carbon atoms and then fusing them properly with 12 pentagonal groupings of five carbon
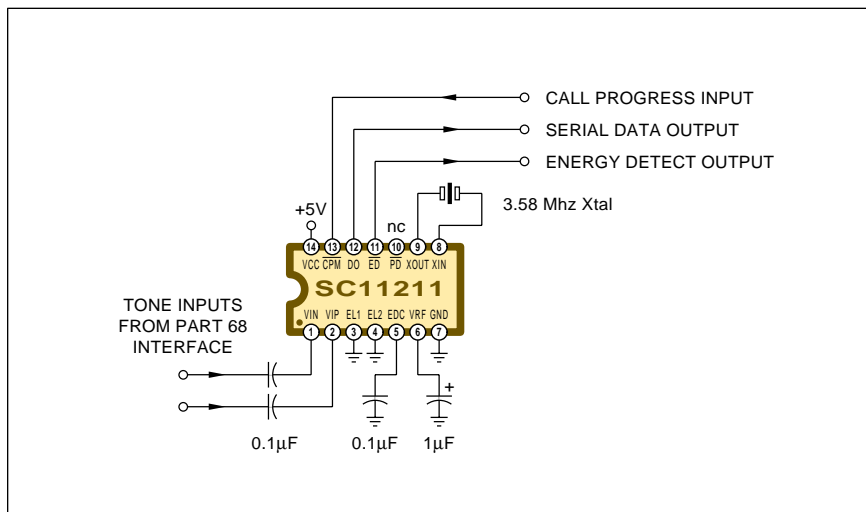
Fig. 5 – A CALLER ID ANALOG FRONT END that makes use of the Sierra Semiconductor SC11211 chip. Low level tones are accepted from the FCC Part 68 interface and get converted into serial ones and zeros.

atoms, a *hollow* geodetic pure carbon molecule of 60 atoms gets created.

Since this hollow all-carbon C-60 molecule looks like a geodetic dome or a socker ball, they were promptly given the name of *Buckyballs*, named after the late Buckminster Fuller, a leading early proponent of geodetic dome structures.

Initially a few C-60 molecules were painfully hand collected, measured, and tested. And, sure enough, C-60 is for real. An experimental proof of the Buckyball shape has recently shown up (Hawkins, *Science*, v252, p312), along with a fine bibliography.

After the discovery, several other chemists (Kratschmer, et al. *Nature* v347 on p354 (1990)) were playing around with carbon rods in a plain old arc welder and figured out how to make lots of Buckyballs in a process almost as complicated as smoking a piece of glass with a candle.

As a result, the price of Buckyballs has plummetted to an astonishingly low $1200 per gram. Quantity pricing is even less, and 100 milligrams of Buckyballs are available for $250 if you are on a limited budget. You can get all the Buckyballs you want off the shelf from *Materials and Electrochemical Research*.

The latest games include putting Osmium "handles" on a Buckyball to make them easier to align, and adding precise doping impurities to create several new families of "Dopeyballs".

While nobody has yet come up with a proven commercial use for Buckyballs, they are now by far the hottest topic in physical chemistry. Buckyballs will even superconduct, although only at rather low temperatures so far. The hollow molecule suggests all sorts of stunning new possibilities which include super lubricants, new batteries, ultra-strong fibers, improved semiconductors, and entire new classes of materials and compounds.

Needless to say, Buckyballs are a sure fire winner for a Science Fair topic or school research paper. And we here at **Radio-Electronics** would certainly be most interested in any Buckyball project which was even remotely releated to electronics. Let us know what you can do here.

Ongoing info on Buckyballs will appear in those *Science* and *Nature* magazines, and, of course, through the *Dialog Information Services*.

Electric Power Research Institute

EPRI is a rather low key research consortium. You have to be a power company to join them. Even then, their annual membership fees are astronomical. But, with their $400 million annual budget they now do all sorts of top quality energy research, including thorough coverage of such subjects as solar power, efficient lighting, cogeneration, conservation, environmental quality, cold fusion,

NAMES AND NUMBERS

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and alternate energy sources. Plus, of course, nasty old nuke stuff.

EPRI does have plenty of videos, technical reports, papers and such available. They also have products for licensing. The summary report of most of their recent key papers costs $45. You might like to contact them directly for further info.

New Tech Literature

A new method of focusing X-rays known as a *Kumhakov lens* is now described on page 208 of *Science* volume 252. If it proves as good as it looks, this could revolutionize everything from high density integrated circuits to safer dentistry. The lens consists of scads of glass capalaries, and the X-rays skip along the surfaces at low angles, rather than shooting right on through them.

From *National Semiconductor*, a new *General Purpose Linear Devices* data book. And from *SGS-Thomson* a new *Power Transistors Application Manual*. Good stuff.

Satco is a great source for oddball tools and supplies. They usually sell to those school vocational education programs. They do have a great new thousand page catalog available.

Unusual scientific images of all sorts of geologic, oceanographic and atmospheric stuff is available on a GRIPS-2 CD-ROM from *Meridian Data*. It is part of a new program to release obscure government research to a wider audience.

Our unusual trade journal of the month is *Power Quality*, aimed at the higher end users of uninteruptable power supplies.

Chip capacitors and resistors for surface mounting are now finally becoming widely available in small quantities at sane pricing. While *Mouser Electronics* is a good source, some ready-to-go $49.95 resistor and capacitor kits are available through *Communications Specialists*. That's three cents each for the resistors and fourteen for the caps.

Turning to my own products, for the fundamentals of digital integrated circuits, do check out my *TTL Cookbook* and *CMOS Cookbook*. Or you can pick up all of those "oldies but goodies" all at once in my *Lancaster Classics Library*.

My website is *www.tinaja.com*

Besides all of the PostScript and desktop publishing stuff, you'll find all sorts of ongoing *Hardware Hacker* and *Midnight Engineering* resources here. You can get your voice connect info by dialing (800) 638-9636.

We also now have the *Hardware Hacker III*, *Ask the Guru III*, and the new *Midnight Engineering I* reprints available, which have the latest and best of all these columns in them. All edited, revised, and indexed.

Finally, I do have a new and free mailer for you which includes dozens of insider hardware hacking secret resources. Write or call for info.

Our usual reminder here that most of the items mentioned pear in the *Names and Numbers* sidebar.

Let's hear from you. ✦