SPECIAL SECTION

CEBus Update: More Physical Details Available

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It's that time of the year again. Flowers are blooming, people are sunning themselves at the shore, and CIRCUIT CELLAR INK is publishing its home automation special section. And what would that section be without a CEBus update? The CEBus committee has been hard at work over the last year revising preliminary specifications released for comment and putting the finishing touches on new specs. As a result, I'd like to bring you up to date on the latest in the CEBus arena.

I don't plan to cover in detail any portion of the spec which has gone largely unchanged since my last articles (CIRCUIT CELLAR INK #10 and #15). I'd start to sound like a broken record. Those who may have missed my previous articles should look them up for a complete background of CEBus. However, so as not to leave those unfamiliar with CEBus out in the cold, I'll give a brief overview of just what it is before getting to the good stuff.

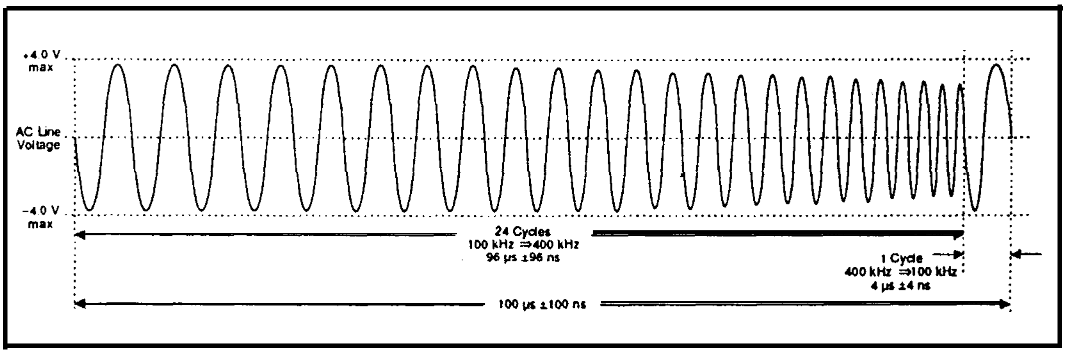


Figure 1—*The waveform used by the new power line specification sweeps from 100 kHz to 400 kHz over a 100-microsecond unit symbol time.*

THE BASICS

CEBus is the Electronic Industries Association's (EIA) standard for home automation. It has been slowly (ever so slowly) evolving for about the last seven years as a result of the efforts of a committee made up of representatives from companies in the electronics industry. Its intention, once complete, is to allow a unified method of communication between virtually any electronic device found in a typical home.

Ideally, any CEBus-compatible product will be able to communicate with any other CEBus product regardless of who made them. The immediate advantages of such a system should be obvious: The herd of hand-held IR remotes clustered on the arm of your easy chair can be replaced by a single CEBus-compatible remote that not only controls your TV and VCR, but can also be used to adjust the room lighting and temperature, open the

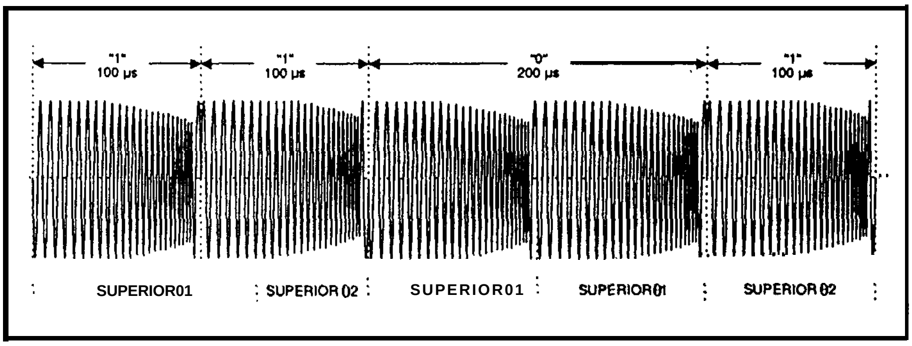


Figure *P-Data encoding is done by alternating between two states which differ only in phase (they are 180° out of phase).*

rior state lasting one UST. If this all sounds confusing, it will become clear when I get to the actual medium definitions and some examples.

The CEBus committee decided (wisely) that, rather than hold up the entire spec for all the Physical Layer definitions to be completed, they'd release the spec in stages as it was ready. The upper network layers plus the power line Physical Layer were released first, and a number of other Physical Layers have been released since. From this point on, I'm going to concentrate on the details of those Physical Layers.

To emphasize the same cautions I've expressed in previous articles, the details I present here are based on preliminary specifications which still must be finalized before they can be used for production designs. I also leave out a good deal of detail that, while is boring and useless in the context of a magazine article, is necessary when designing a product that conforms to the complete specification. If you have any plans for designing CEBus into a product, please contact EIA directly to get the complete text of the specs released so far and suggestions for conformance.

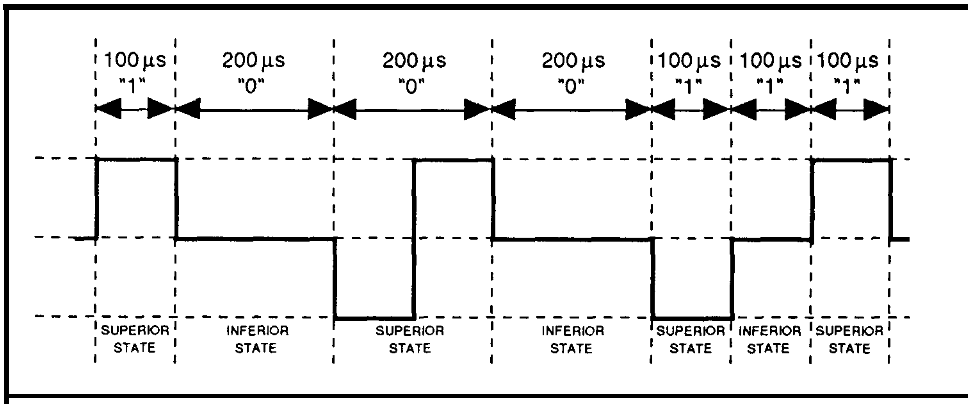


Figure 4-Twisted *pair uses a signaling scheme that can be confusing at first.*

POWER LINE

If you've been following CEBus developments, you probably read about how the power line spec used a 120-kHz carrier and ASK signaling to achieve a paltry 1000 "one-bi t"-per-second data rate (a UST of 1 ms). Adding safeguards to prevent against false triggering of X-10 modules (which also use 120-kHz signals) reduced the effective data throughput even more.

Well, forget everything you've read. In last year's article, I made a comment that "perhaps a better method will be suggested during the comment period that will be enough of an improvement to prompt the committee to supplement or replace the proposed method." Fortunately, enough complaints were lodged during the comment period that the committee essentially threw away the proposed method and started again from scratch. What we've ended up with should assure quick acceptance of power-line-based CEBus products and will hopefully help stimulate its growth in the very lucrative retrofit market.

The new method, originally proposed even before the first spec was released, uses a form of spread spectrum signaling. When dealing with a fixed-frequency carrier (e.g., 120 kHz), thatcarricrisvcrysusceptible to noise since a burst of garbage that happens to contain that particular frequency will mask out any real information. In the new spcc, the carrier is swept from 100 kHz to 400 kHz over a 100-μs UST. Since a broad spectrum of frequencies is being used, a random burst of noise is much less likely to cause errors. The shorter UST results in a data rate of 10,000 "one-bits" per second (which is consistent with most of the other media).

Figure 1 shows the waveform used. The sweep actually ends up back down at 100 kHz by the end of the period, as can be seen on the right side of the waveform. The decreasing amplitude at the higher frequencies is intended to reduce RF noise to keep the FCC happy.

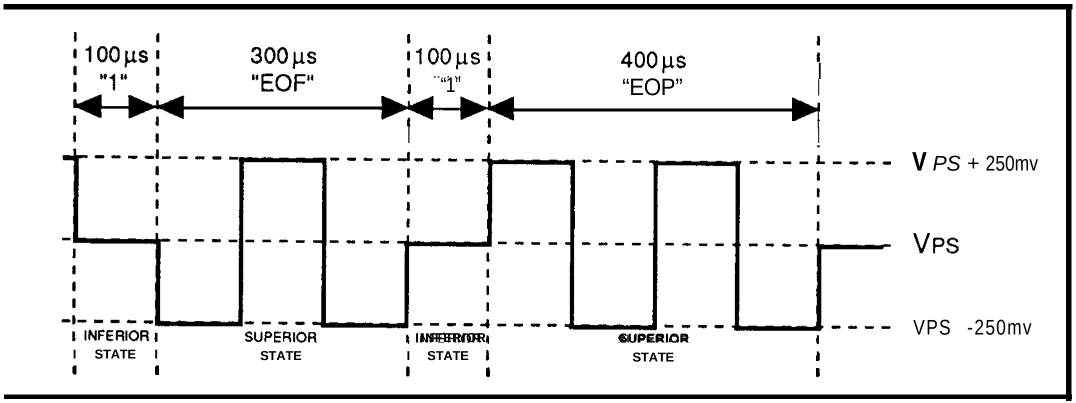
The new spcc complicates things a bit by defining not just one but two superior states: SUPERIOR01 and SUPERIOR02. The two are identical but are 180" out of phase. In addition, there is the normal INFERIOR state which is nothing but silence. (Note that this terminology is based on a spcc which was virtually days away from final rcleasc, so slightly different wordingmaybeuscdin the final spec.) During the preamble period, SUPERIORθ1 and INFERIOR are used for encoding so that collisions can be detected (by listening during INFERIOR). Once the channel has been seized and data starts flowing, encoding is performed by alternating between SUPERIOR01 and SUPERIOR82 as in Figure 2.

Current plans are for Motorola to produce the first chips to support this scheme, with first silicon showing up about when you read this. Tests with working prototypes show the new method far outperforms the older method in terms of data integrity and speed with an array of typical power line noise induced on the line. Expect to see some very impressive power-line-based products showing up on the market within the next year or so.

INFRARED

The first new spec to be introduced after theinitial roll-outshowed up around August '90 and was for IR. Many observersexpect the hand-held IR remote control to be the main user interface to the house since it is already familiar to most, is easy to use, is very portable, is inexpensive, and can be used from virtually anywhere in the house with receivers placed at strategic locations. In addition, TVs around the house can be used as display devices to offer the user feedback.

The signaling method for IR is very straightforward. An IR carrier in the range of 850-1000 nm is modulated with a 100-kHz subcarrier (most hand-held remotcs these days use 40



kHz). The presence of this subcarrier represents the superior state while its absence represents the inferior state. The transmitted signal alternates between the superior and inferior states, with the length of those states representing the symbol being transmitted. Like the new power line, a UST of 100 µs is used for an effective data rate of 10000 "one-bits" per second (which probably explains why 40 kHz wasn't used). Figure 3 shows what the signal looks like.

There really isn't much more to it. The spec is the thinnest so far released simply because it's the easiest to describe. There are of course other details related to duty cycle and transmitter power, but I won't get into that here.

TWISTED PAIR

The next spcc to be released came about two months later and is for twisted pair. This one is going to be important whendealingwith devices such as telephones, intercoms, and even thermostats and motion sensors. These are all items which have traditionally used a single twisted pair to communicate through the house, and they'll likely stick to that medium.

There are two key sections of the spec that I'll concentrate on: one that defines what the signalson the wires look like, and the other that defines the wire topology and connectors.

All the CEBus media technically have a control channel and a data channel. On both power line and IR, only the control channel is defined in the first release of the specs. A data channel for each may come at some time in the future. With TP, though, both control and data channels are defined.

The TP control channel uses a 100-µs UST for a data rate of 10000 "one-

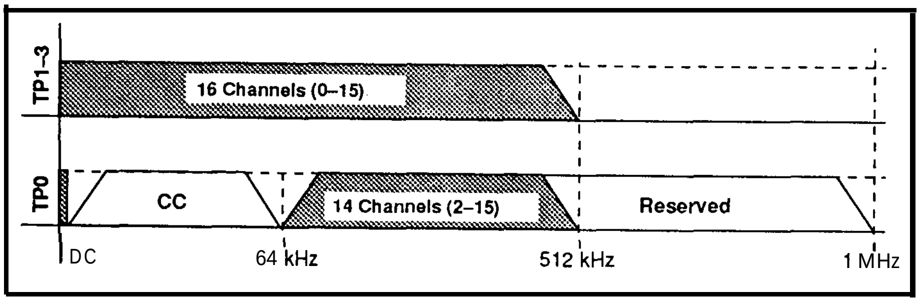


Figure 5a—*TP0 consists of DC power, a control channel, and 14 data channels. The other three pairs consist of 16 data channels each.*

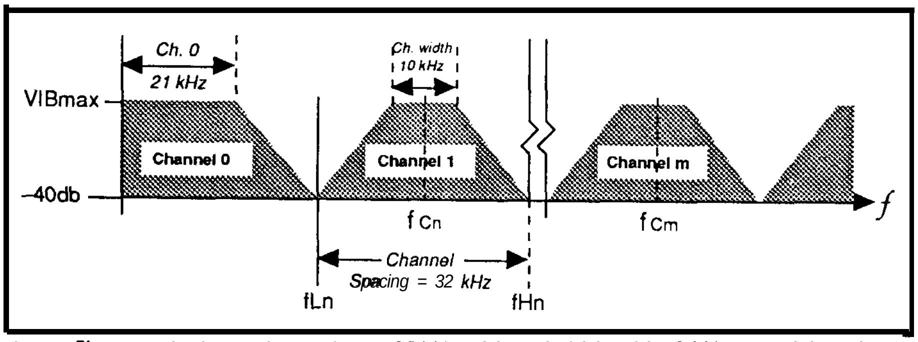


Figure 5b—*Each data channel uses 10 kHz of bandwidth with 11-kHz guard bands on either side. Adjacent channels may be combined when greater bandwidths are needed.*

bits” per second. Rather than use discrete signal levels to denote the superior and inferior states, transitions between levels are used to denote each state. A transition once per UST denotes a superior state while the lack of a transition denotes an inferior state. As with the other media, signaling alternates between superior and inferior states with the duration of each state representing the symbol being sent. The example in Figure 4 shows it much better than I could ever hope to explain it.

The transitions occur around the average DC level on the wire pair, which is actually the power supply for devices that wish to draw power from the bus. The signal level varies between the power supply voltage, the voltage plus 250 mV, and the voltage minus 250 mV. The power supply voltage can be between 16 and 18 volts depending upon the load.

The data channels are frequency multiplexed onto the same twisted pair. The control channel is defined to occupy a region in the frequency spectrum from DC to 64 kHz. Fourteen data channels are then defined starting at 64 kHz and progressing up to 512 kHz in 32-kHz blocks (10 kHz of usable bandwidth with 11-kHz guard bands on either side). When there is more than one wire pair installed (more on that in a moment), TP0 contains the power supply, control channel, and fourteen data channels. The other pairs contain sixteen data channels each, starting at DC and going up to 512 kHz. Figure 5 shows how the channels are set up.

You say 10 kHz of bandwidth isn't enough? The spec allows for channel concatenation for such situations. When two adjacent channels are combined, you end up with the 10-kHz normally associated with each, plus the guard bands that would normally separate them, for a total of 42 kHz. Concatenating four adjacent channels would result in 106 kHz of bandwidth.

On the wiring side of things, the specification offers a number of options; which one you use depends on your setup and type of equipment. A full-blown CEBus-only system consists of four twisted pairs running to each room from a central location, resulting in a control channel and 62 10-kHz data channels. The connector, shown in Figure 6, is an &position RJ-type jack.

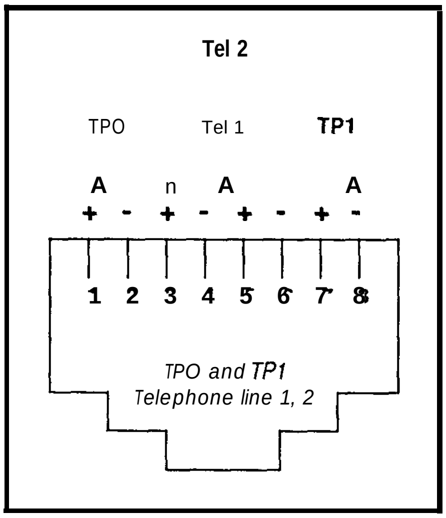


Figure *6-A single wall jack can be used by both CEBus-compatible devices and old-style* telephones.

For those instances where you still have conventional telephones, but want to add CEBus twisted pair, the spec calls for two pairs to be used for CEBus and two pairs for use by conventional telephones. The same 8-position jack is used, with the CEBus connections on the outer pins and the telephone connections on the inner pins where they would be in any conventional installation (see Figure 7). CEBus devices with 8-pin plugs can be attached and will use TPO and TP1. Regular telephones with 6-pin plugs will also plug into the same jack, but will only use the inner two (or four) wires, leaving the four outer CEBus wires untouched.

In the last configuration, conventional 6-position telephone jacks may still be used for conventional telephones, but since CEBus devices will have 8-pin plugs, they can't be plugged into the 6-position jack (which would be pointless anyway).

There is no requirement as to how many pairs must be run in an installation. A single pair may be all you have already installed and may be sufficient to handle the load. Any number of pairs up to four may be used.

COAX AND RF

There isn't a lot to report here. The last schedule I saw calls for both proposed standards to be ready at about the time you read this, but since most of the others have come in behind schedule (IR and TP were exceptions, though), don't expect to see these two for at least a little while.

It really doesn't matter if these two take a bit longer, though. Coax will likely be used mostly in new construction or remodeling, so isn't as important in the retrofit market. I see RF as being important in the long run, especially-in retrofits, but not-right away. Power line and IR will be the big two, with twisted pair coming in third. With these three in the bag, manufacturers will finally be able to start making products with built-in CEBus.

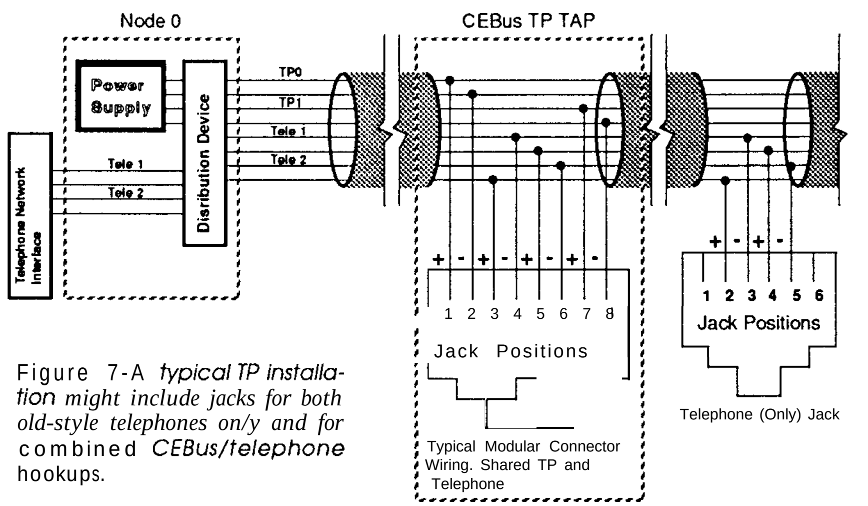


Figure 7-A *typical TP installation might include jacks for both old-style telephones on/y and for* combined *CEBus/telephone* hookups.

BRIGHT IDEAS

So where are we with CEBus? We're a lot farther along than we were a year ago, but not as far as I'd hoped. It's still going to take a few years before you see CEBus built into products,and thecapability will likely start at the high end and work its way down in the product line. Just look at MTS stereo in TVs and antilock brakes in automobiles. I've been hearing about some nifty products on the drawing boards (none that I can talk about, though), so I'm looking forward to the next few years with a great deal of anticipation.

As for a development that is here today, though, Indianapolis Power and Light Company and PSI Energy have built what they call their "Bright Home." Cited as the nation's first CEBus demonstration home, it was officially opened on March 20, 1991, and will be available for six months thereafter for "tours by the media, consumers, companies, governmental agencies, and representatives from academia."

Companies supporting the project with fully functional prototype products include Johnson Controls, Panasonic, Somfy Systems, Sony, Square-D, Thomson/RCA, and Universal Electronics. The Bright Home was introduced in conjunction with the Ninth Annual International Energy Efficient Building Association (EEBA) Conference and Exposition and is claimed to be so efficient that it can be heated and cooled for $19 a month.

Maybe a trip to Indianapolis could be arranged soon.. .

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Thanks go to Tom Mock and George Hanover of EIA for their continued support of my efforts to keep our readers informed.

IRS

416 Very Useful
417 Moderately Useful
418 Not Useful