Reading Your New Trouble Card

Introduction

Thanks for your donation to the Telecommunications History Group (the non-profit organization that runs the Connections Museum Seattle and Denver). As an extra special gift, I thought it might be cool to include a little instruction booklet on how to read and interpret the punchings on these trouble cards.

When selecting cards to mail out, I tried to pick something interesting, that was also visually attractive. I avoided cards that only had one or two punches, or any that were obviously nonsense. I did not necessarily diagnose the problems on each card though, so for all we know, you might be the first person (or at least the first in a long time) to discover the hidden meaning in your card! Exciting!

Reading a Trouble Card

Reading a trouble card properly is equal parts art and science. It's important to understand the technical meaning of the punches, and what they imply in the context of the larger system, and it also takes a certain "knack" (or intuition) to look beyond the specific indications on the card and into the "feelings" of the machine. This isn't something that most people can do correctly their first time, but it's still fun to try!

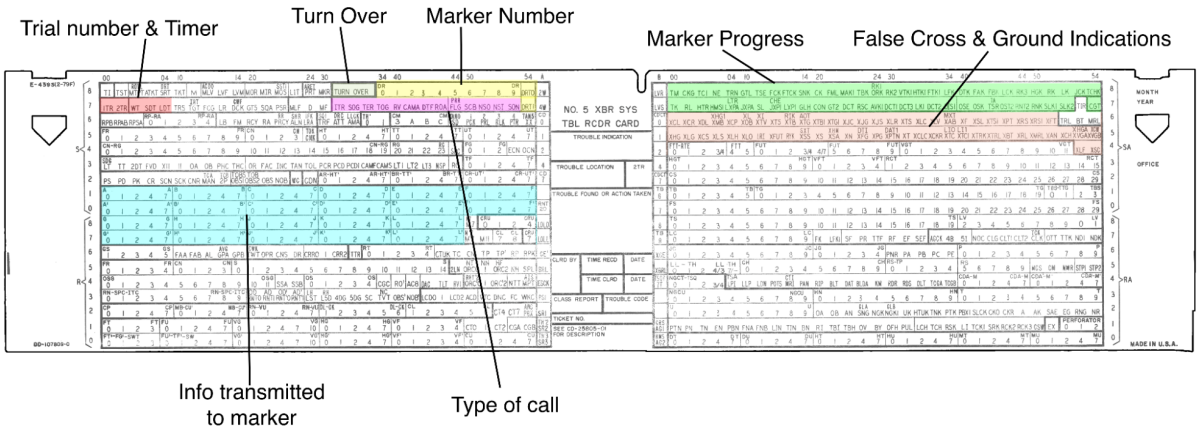
Before we get into the good stuff, there's a few caveats to watch out for. Because the designers at Bell Laboratories wanted to make things fun for everyone, they made sure that many punches have two (or even three) meanings, which change depending on the context of the card. Therefore, it is helpful to look for certain "key" indications first, which will determine how to read the rest of the card.

It's also worth noting that a single trouble card often did not contain enough information to accurately pinpoint the problem. Many troubles were transient in nature. Others occurred intermittently, or only when a specific subset of equipment was engaged on a call. Almost anyone experienced with troubleshooting will know that sometimes you have to watch the problem occur many times before you can establish a root cause. It's no different here! If Marker 1 drops several cards in one day, it's likely the problem might be in that marker. In other cases, several cards may be dropped by different equipment, but all originating at the

same subscriber line. (One of the things that I do to compare a set of suspicious cards is to stack a few of them and look for common punchings that exist on all of them.)

Finally, having real-world experience with the machine you're troubleshooting is invaluable. If you've been working with a particular piece of apparatus, and it drops a card, you can probably guess exactly what happened even before you see the full card. Oftentimes, whoever was working on the equipment most recently became the "owner" of that equipment. One museum volunteer, Bob, recalls how he'd come into work in the morning, and the night shift guys would say "Hey! Your marker dropped a card again!". Bob wondered at how it became "his" marker, simply because he was the last one to work on it. Nonetheless he almost always knew what the problem was, and went to work on fixing it right away.

Parts of a Trouble Card

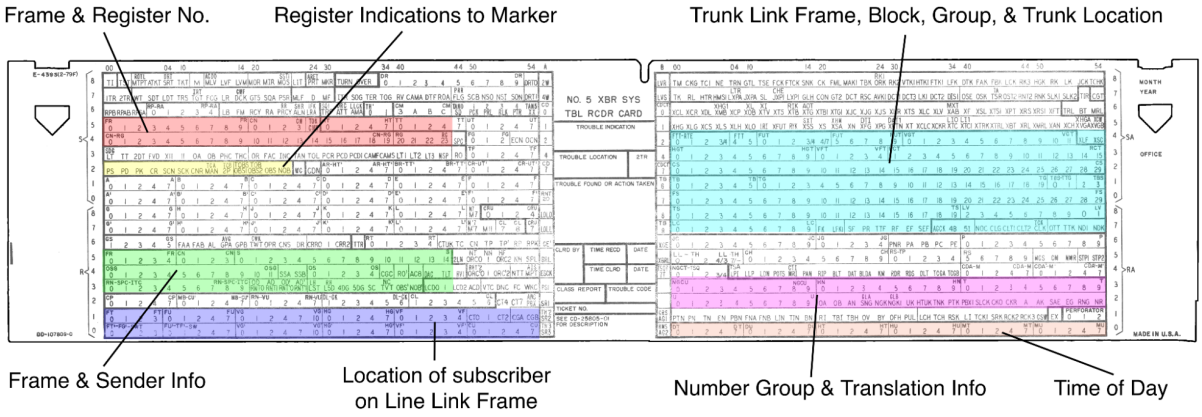


The trouble card you have probably has a front and a back. The front side has the cutouts at the *top of the card.* For most of our work, we'll be using the front, so we can ignore the back for now.

The image above shows the front of an E-4393 card, which is the standard type we use at the museum. There are other types, but this should suffice for now. Certain key areas are highlighted to indicate things that you should look at first. These areas will give you important contextual information that you can use to digest the rest of the card later. (If I'm reading a card, these areas are where my eyes will instinctively look first.)

- **Trial number & timer** - Usually, more than one attempt will be made to complete the call. The trial number indicates if this card was dropped on the first or second attempt. The timer that expired helps to show where progress stopped, as each timer guards a specific subset of operations.
- **Turn Over** - Read the back side of the card!
- **Marker number** - This is the marker that dropped the card. If the card was dropped by a transverter (for AMA) or a pretranslator, this number would indicate that equipment number instead.
- **Info transmitted to marker** - Originating Registers (ORs) and Incoming Registers (IRs) will transmit numbers to markers for call completion. Digits from ORs come from subscribers dialing their telephones. Digits from IRs come from other telephone switches transmitting the information over trunk lines.
- **Type of call** - Markers complete many different kinds of calls. In each type of call, they go through several discrete stages. These punchings can change the meaning of other punches later on... Example: "The marker was completing the FLG (*forward linkage)* stage of an ITR (*intraoffice*) call, therefore the FS and TS punchings refer to the forward linkage trunk-link used, and not the *call-back linkage* trunk link."
- **Marker progress** - Complicated! As the marker completes the call, certain events happen in a known order. These punchings tell you what events completed, and what events have not. Context is super important, since events happen differently for different calls!
- **False Cross and ground indication** - These will be punched if the marker detected a false cross or ground on any equipment while setting up the call. If any of these are punched, that's almost certainly the reason the card was dropped!

Diving Deeper



The rest of the card contains the specific information from each piece of equipment that was used on the card. Once you have the basic context, these will point to the exact location of the failure.

- **Frame & Register Number** - If the marker was called in by an Originating Register (OR) or Incoming Register (IR), this will show the frame number, and the register number that was being served.
- **Register Indications** - Registers have their own progress and status indications. Example: “PD” means Partial Dial, and “SCN” means “Stuck Coin” (in a payphone).
- **Trunk Link Locations** - Used to determine the physical parts of the switching fabric that the call was completed through. From these indications, a trained craftsperson can point to the exact set of crosspoints that was closed to connect the call.
- **Frame and Sender Info** - If this was an outgoing call, these punchings indicate which sender was used, and any special instructions that were transmitted to the sender from the marker.
- **Location of subscriber** - For calls that originated from a local subscriber, these punchings indicate the specific location of that subscriber’s line on the Line Link Frame.
- **Number Group Info** - For calls that terminate to a subscriber on this machine, this indicates the status of the translation from a telephone number into a physical location where the call will land.

- **Time of Day** - Expressed as Days Tens, Days Units, Hours Tens, Hours Units, Minutes Tens, Minutes Units.

Be aware that not all areas will be punched! If an area doesn't contain any punches, it just means that either the call didn't reach this stage, or the call didn't require use of this equipment. (Example: An SOG (*subscriber outgoing*) call doesn't require a number group translation, so this information won't be present.) This is an example of why context is so important.

Using all of this information, you can look at your card and determine roughly what equipment was used to complete the call, and perhaps identify why your card was dropped.

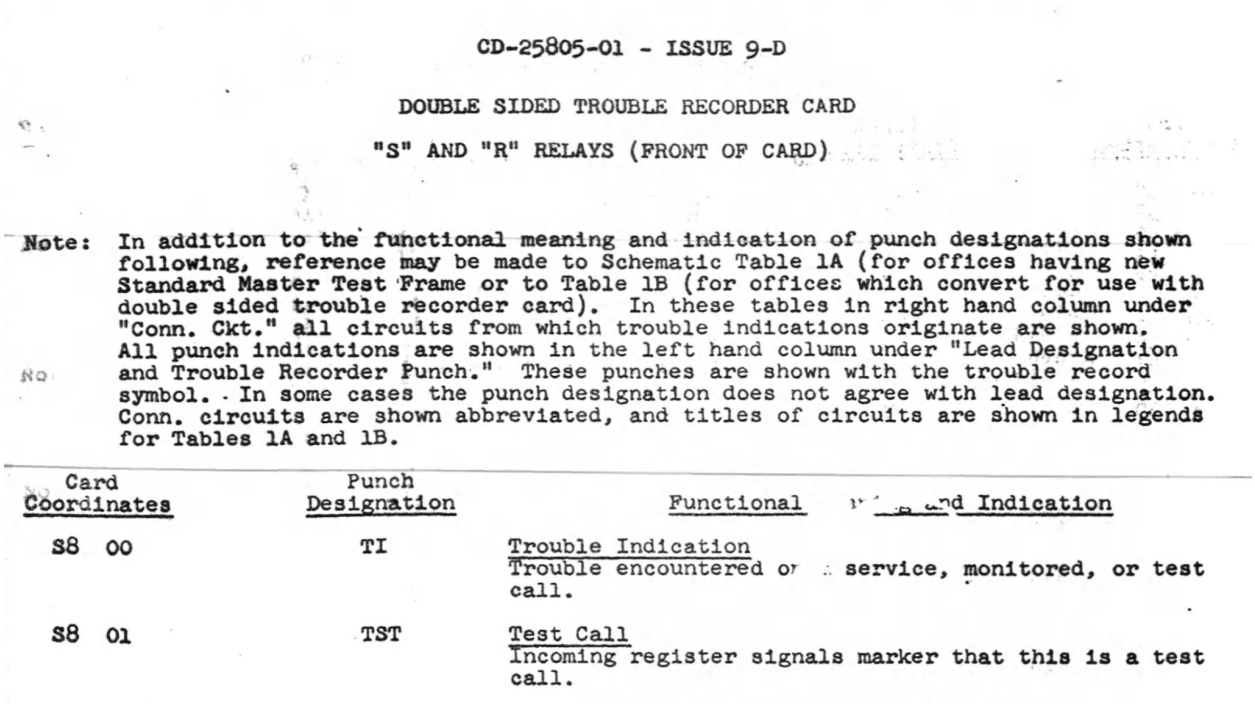
Further Reading

If you want to find out what a specific punch means, or understand the marker progress indications, then you'll want to dive into the reference materials. They are long, voluminous, and complex, but never fear! We'll get you started ;)

Trouble Card Reference

https://archive.org/details/bellsystem_trouble-card-reference

This document is where I go when I want to know what a particular punch means. You can even see me use it during the most recent YouTube video where I look up the meaning of the "TSE" punch. The good stuff starts on page 96. (*Warning: the page numbers are not consistent across the document.*) The PDF is OCR'd so if you download it, you can just search for a specific punch and go directly to it.



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DOUBLE SIDED TROUBLE RECORDER CARD

"S" AND "R" RELAYS (FRONT OF CARD)

Note: In addition to the functional meaning and indication of punch designations shown following, reference may be made to Schematic Table 1A (for offices having new Standard Master Test Frame or to Table 1B (for offices which convert for use with double sided trouble recorder card). In these tables in right hand column under "Conn. Ckt." all circuits from which trouble indications originate are shown. All punch indications are shown in the left hand column under "Lead Designation and Trouble Recorder Punch." These punches are shown with the trouble record symbol. In some cases the punch designation does not agree with lead designation. Conn. circuits are shown abbreviated, and titles of circuits are shown in legends for Tables 1A and 1B.

Card Coordinates	Punch Designation	Functional [illegible]nd Indication
S8 00	TI	Trouble Indication Trouble encountered o[illegible] service, monitored, or test call.
S8 01	TST	Test Call Incoming register signals marker that this is a test call.

Here, punches are organized according to their coordinates on the card. Rows are referred to by a letter and a number. Punching "S8 00" refers to the first punching in the top left row on the card. You should be able to see the row and column numbering on the card.

(Interestingly, the E-4393 double sided cards have weird column indications that I still do not understand. The older, single sided cards have sensible columns. Thanks Bell Labs!)

System Functional Diagrams

https://archive.org/details/bellsystem_no-5-crossbar-functional-drawings-sfd-10-01

The “SFDs” are my go-to reference for a deep technical understanding of these cards. They consist of several thousand pages, and are *not* for the faint-of-heart. However, they are the best place to go in order to understand the complex marker progress indications in the upper right portion of the card.

Page 22 / “A204” of Volume 1 has a flowchart that can point you in the right direction. Once you reach the end of the flowchart, it will direct you to another page that has the overall sequence chart for that problem.

For example, you might be pointed towards C202 on page 213, which will show you just the key progress indications for *outgoing sender selection.* From there, the card is examined to see which holes are punched and which are not. Once you reach a hole that's not present (but should be), you can close in on your particular problem.

The System Circuit Descriptions that accompany the Functional Diagrams provide written descriptions for diagrams. They are located at this somewhat unwieldy URL: https://archive.org/details/bellsystem_no-5-crossbar-circuit-descriptions-scd-10-01

Epilogue

I am constantly amazed by the complexity of these machines. I've been working on them for almost 6 years (as of this writing), and I am *still* learning more about them every day. It speaks to the spirit of the designers and maintenance personnel that they worked so well for so many years, and continue to do so, well after their projected lifespan has ended.

Troubleshooting them is no easy feat. Maintenance staff were sent to school for *months*, and then subjected to many months more of real-world experience in the hands of a skilled worker before they could begin to do their own work. As we mentioned in the beginning of this document, doing so was equal parts art and science, and maybe just a little bit of magic.

The magic element in particular is why I semi-seriously adopted the title "switch witch" to refer to my work at the museum. I feel the same sense of wonder and intrigue here that I feel when learning about the deep inner workings of the universe, and the human mind. These truly are wonderful creations, each with their own moods and feelings. Working with them often feels like hanging out with friends.

I hope you enjoy your little trouble card. Thank you for your donation! We all appreciate it, and hope to see you one day soon!

-Sarah