Telegraph Impression Best Practices Manual

For use by:
The Idaho Civil War Volunteers

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Best Practices Manual Use

The guidelines presented in this Best Practices Manual provide the necessary framework and information to implement a historically accurate telegraph impression in the Idaho Civil War Volunteers (ICWV) organization. Concessions recommended in this manual in lieu of absolute historical accuracy reflect the 21st century constraints encountered when trying to implement 19th century telegraph standards. Through these best practices, recommended authenticity guidelines related to equipment, operating procedures, safety, and period dress is presented. "Our goal is to bring the past into the present, stimulating interest in the American civil War, and provide an understanding of people's experiences of the time."

These guidelines are used for both reenactments and living history presentations. It is important that we present the activities conducted during the recreation of Civil War events as accurately as possible. Deviations from historical accuracy should be fully explained to those watching the activity. It would be a travesty is someone left one of our presentations with the wrong idea about the way things were.

Although this Manual describes how to do a 19th century impression today in the ICWV, it is recommended that the person doing the impression study the history of the telegraph to get a clear picture of how it used to be. If you wish to be a living historian, you must learn the history from reliable sources. That typically takes some level of effort that needs to be invested to do a credible job.

Finally, we necessarily need to make some concessions related to historical accuracy of equipment because of availability and safety. However, that is not the case when it comes to procedures and what might be termed "soft goods". The procedures listed for message preparation for example, are completely accurate. Where it is only a question of learning how the "old guys" did something procedurally, it is incumbent upon us to do it just that way. Doing anything else means that we are no longer reenactors but we are actors describing events that may or may not be true.

References

The following references were used in preparing these guidelines:

1. Western Union Company Rules, Regulations, and Instructions dated 1866
2. 1859 Western Union “92” Code found in The Telegraph Instructor by G.M. Dodge 1911.
3. The Telegraph Manual: A complete History and Description…by Tal. P. Schffner dated 1859
4. The Military Telegraph During the Civil War in the United States, by William R. Plum dated 1882
5. History, Theory, and Practice of the Electric Telegraph by Prescott dated 1866
6. Lee’s Despatches edited by Douglas Freeman dated 1858
7. The Electric Telegraph by Franklin Pope dated 1870
8. Lincoln in the Telegraph Office by David Homer Bates
9. History of the Signal Corps by J. Willard Brown
10. Official Records (OR) 1864
11. L.E. Trump power supply circuit designs
12. G. Raven and his Polar DC interface device with dial-up system
13. Signal Corps Association Reenactors Division (SCARD) web site
14. Ohio Valley Civil War Association web site
15. Morse Telegraph Club Alexandria Washington
16. Mr. Lincoln's T-Mails: How Abraham Lincoln Used the Telegraph to Win the Civil War by Tom Wheeler

ICWV Telegraph Portrayal

The telegraph organization within the ICWV is formed as the Union Military Telegraph Service or UMTS. Thus we are a Union organization. Operators are usually attached to Union Commanders in their field telegraph offices and at the “Whitehouse.” Officially, we would take our direction from the Secretary of War through the Quartermaster Corps and our officers. There was a Colonel in charge of the UMTS functions at the onset of the War and he was stationed in Ohio. His name was Anson Stanger. However he really did not impact the daily telegraph operation that much. A Major, T. T. Eckert who was eventually stationed at the Whitehouse performed the daily UMTS management functions under the direction of the Secretary of War even though the telegraph functions were originally assigned to the Quartermaster Corps. In 1861 the chain of command was altered because of an incident involving Gen McClellan, Secretary Stanton, the then Capt Eckert, and President Lincoln. The new chain of command begins in the political arena with the President (A. Lincoln) to the Secretary of War (Edwin M. Stanton) to the Telegraph Superintendent of the War Department Maj. Eckert. Under the reorganization, all the telegraph operations were centrally placed at the War Department. Capt Eckert was promoted to Major and was effectively placed in charge of all telegraph operations for the Union. Thus the connections to Col Stanger and the Quartermaster Corps were effectively eliminated although remained on paper. The Major eventually became the Assistant Secretary of War and the chief aid de camp to the President during the War. After the War, he was promoted to the rank of General. In other words, during the War, the telegraph folks had their own chain of command separate from the commanding officers in the field. This was not the case for the people with signal flags and torches (visual signals) in the Signal Corps. As can be imagined, that made for some interesting situations.

The UMTS within the ICWV is led by a Major (T. T. Eckert). Considering the ICWV has no political chain of command, the UMTS chief reports to the ICWV commander. People performing telegraphic duties in the field are Union Privates and civilians. The UMTS is therefore a civilian bureau with military people assigned and a military person in charge.

Operator duties include sending and receiving telegraph messages, encoding and decoding messages using cryptology techniques, setting up, maintaining, and taking down telegraph equipment. Because of the ICWV organizational size, sometimes telegraph operators will perform “cross communications.” One operator will be stationed in a Union camp while the other is in a Confederate camp. Telegraph operators are non-combatants although they are subject to capture. The stations can be subjected to acts of sabotage. Operators may engage in spy and espionage activities.

Telegraph Instruments

Defining what the various telegraph instruments used during the Civil War were is fairly straight forward. Getting Civil War era instruments to use in our activities is another matter. Several sources were used to determine the instrument types employed during the Civil War. The SCARD forum provided a great deal if information along with the information in the Morse Telegraph Club archives. Other selected reading listed on the reference page provided more detail. Through the research assembled, an accurate picture of 19th century telegraphy especially during the Civil War can be obtained.

A discussion of the telegraph circuits is necessary to appreciate the type and style of instruments used in the 1860's. According to "The Telegraph Manual…" by Tal. P Shaffner published in 1859, the typical circuit was a set of mainline instruments connected in series with a set of batteries, or cells providing power. They had a ground system at the terminal stations. That means they most likely did not use a "metallic" telegraph except for perhaps private lines and/or very short runs. According to both Pope in his book entitled "The Electric Telegraph" and Shaffner, the potential of the line was 60 volts or more. Typically, the mainline instruments included a key and a relay at each station. The relay was usually 150 Ohms. Prescott noted in his book "History, Theory, and Practice of the Electric Telegraph" written in 1866 that they used a resistor, in fact a rheostat to limit the current on the line depending on the number of instruments "cut-in" the line. The line appeared to run at a nominal 50 ma when all the keys were closed. The relay controlled a local loop at each station. The local loop had a receiving instrument like a sounder connected to a local battery of one or two cups (cells). Because of the number of cells involved, the local loop typically had a potential of between one volt and three volts depending on the battery type and condition. Given that the local devices were four to twenty ohms in resistance, the local loop current was high. Therefore a minimum complete station consisted of a key, a relay of 150 ohms, and a low resistance sounder. A register or printer used as a receiving instrument was either a mainline or local device in 1860. Large offices had multiple lines and used switches to direct the line to appropriate tables. The receiving instrument of choice by 1859 was the sounder. Some of this can be seen in a picture of a Union Military Telegraph (UMTS) Civil War telegraph field station where the relay is just visible. Pictures, or plates, in the Shaffner book show what the instruments looked like in 1859, and Prescott describes them in his book as well. Pope has some great illustrations, but his book was published well after the war. In the Pope book, you can clearly see how things progressed during the 1870's. Also in Pope, the use of the mainline sounder was evident, something absent from the Prescott and Shaffner book. Also absent from the Shaffner and Prescott books are the use of KOB's's[1] in the main line. Reference is given in some MTC (Morse Telegraph Club) literature, and on the bottom of many KOB's that they were almost exclusively used for training or "private lines." Finally, the plates and office descriptions in the Shaffner book or descriptions in Prescott do not show or mention the use of resonators. They seemed to come into play after the war. All this discussion means that we have a fairly complete picture of what the 1860's station, both field and office looked like.

[1] A KOB is a Key On Board or Key on Base

During the war, the G.M. Phelps[2] Camelback leg key was "the" key of choice. Even if we had a real G.M. Phelps key, we most likely would not use it in a telegraph set up, rather it would put on display. Same is true for other instruments and artifacts actually from the war. There are plans available on the web to make a reproduction Phelps key if one is inclined to take on that challenge. A substitute key is a Bunnell[3] leg key, made in the 1880's. There seem to be lots of those around. A Triumph legless key[4] is also a good substitute.

Relays as can be seen in the Pope book and those typically for sale are really different from those used in the 1860's. An alternative is a 150 Ohm Bunnell relay that has a square fixture over the contact points rather than a rounded one. Additionally, for demonstration purposes it is preferable to use only those instruments with thumb screw wire terminals. That is somewhat close, but again, the differences need to be explained.

The sounders used in the 1860's are quite a bit different than what is typically seen today. The photographic plates in Shaffner show the 1860's sounders. The local sounder that is a good substitute is a four Ohm 1875 Tillotson[5]. Even they are hard to find. An alternative is something like a MESCO or Menominee, MI four ohm local sounder. They are plentiful, although the spring return mechanism is in the wrong place for an 1860's version. Again, use those that have thumb screw wire terminals.

In all cases, preference should be given to instruments made in the 19th century. If reproduction Civil War telegraph instruments are available, by all means we should use them. If we insist in using instruments with the same electrical and close physical characteristics, it will put us into at least the authenticity ballpark.

Placing the instruments on a table is another issue. That seems to be what everyone did, but care needs to be take to build the table using period construction techniques. That means for example, no plywood or Phillips screws. Screws used during the 1860's were steel slotted screws. Slotted modern screws can be found, but they are typically zinc coated. The zinc coating can be removed, and the screws "aged" by soaking them in a solution of Muratic acid for a few minutes.

Connecting wire for the instruments appears to be solid copper, something like AWG 16 or perhaps AWG 18. That is based on observation of original wire on a table. The insulation was very stiff, perhaps Gutta-Percha. The AWG 16 or 18 with really old style insulation is available from companies selling antique electronic supplies.

Recapping, our standards in priority order are:

1. Keys

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[2] G. M. Phelps was a telegraph instrument maker
[3] J Bunnell was a telegraph instrument maker
[4] A Triumph key was originally made by Bunnell in 1870
[5] Tillotson was a telegraph instrument maker

    a. GM Phelps or replica
    b. Legged Triumph
    c. Old style triumph with thumb screws
2. Relays
    a. Original 1860's relay or replica
    b. 150 Ohm relay with square bale and thumb screw connectors
    c. 150 Ohm relay with round bale with thumb screws
3. Sounder
    a. Tillotson 4 to 20 Ohm local sounder, 19th century vintage
    b. Four to 20 Ohm Local sounder with thumb screw connecting posts
4. Wire (for telegraph table)
    a. 16 to 18 gauge solid copper with cotton insulation
    b. 16 to 18 gauge stranded copper with cotton insulation
5. Table
    a. Pine or hard wood solid
    b. Screws slotted, not Phillips

Other devices would be great to use in the field including a Beardsley Machine[6]. Originals are extremely rare. However, there is a group in Ohio that has successfully built several reproductions that seem to work well. The Beardsley's were not used by the UMTS, rather they were used by the U.S. Signal Corps[7] for a couple of years. The use of the Beardsley will need to be researched by the person doing the impression to ensure historical accuracy related to implementation.

[6] Beardsley Machine made by the Ohio Valley Civil War Association members
[7] The OR's of 1864 tell of the demise of the Beardsley Machines

Power Supply Systems

Implementing period power systems for the telegraph is easy in some respects, and difficult if not very practical in others. We understand that each station needs two power sources, the main line power either through the line from another station or via a set of cells at the station along with a local power supply of typically two cups. With that knowledge, we can begin to create ways to build or simulate authentic power and power supplies.

Fortunately for us there is a great resource named L. E. (Ed) Trump[8] who has developed a power supply system for telegraph demonstrations. His system replicates the line voltage and provides enough current to emulate what was used in the 1860's. His plans are available on the SCARD site in the Telegraph Section and they are also included in Appendix 1 of this Manual. The Trump Power supply is the power source of choice for our group. The "old guys" used chemical batteries like the Grove or Daniell cell to supply current for the telegraph. They placed the cells in series to get the necessary voltage. The voltage on the line was from about 60 volts and up. The supply needed to sustain a mainline current of about 50 ma. While it might be impractical to build a bunch of Cells (cups) for the mainline, it is quite easy to build two cups for a local loop.

We have many alternatives when it comes to supplying the power needed for the power supplies suggested by Ed Trump. The first is to use a 12- volt battery running an inverter, which in turn runs the power supply. Ed describes two power supplies. One runs at about 60 volts key open while the other provides as much as 120 VDC key open. Both seem to work with a modified sine wave inverter, however the efficiency is reduced. If you desire that the design voltage be reproduced, then pure sine wave inverters will be necessary. The power supply, battery, and inverter along with an ammeter and rheostat all are housed in a period looking wooden boxes. Other methods include using a generator or an extension cord to a current outlet available in most parks to supply current to the power supply.

As mentioned, the local loop can be powered from a replicated set of Daniell cells. A six pack based on what T.T. Eckert described to his boss in June 1864 is constructible[9]. Copper sulfate is not bad as chemicals go, and it is the only chemical that is needed. An alternative is to use dry cells such as hobby batteries, or lantern batteries with resistors. It is also possible to build a DC power supply running from AC mains that provides the three volts. Then you can place it along with the mainline AC supply running off the inverter.

If you simply use one or two 12 volt batteries in series for the mainline depending on the number of instruments on the line, that may work. However, the instruments will not have the "snap" that is desirable when operating with any kind of speed on the line. The old guys knew what that meant, and it is described in Pope, Prescott, and Shaffner. It has to do with a guy named ELI the ICE man.

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[8] Ed Trump is a living historian living in Alaska. He and Greg Raven have developed many systems for living history applications. Ed is also a co0developer of the Morris Telegraph Club Dial Up Morse system.

[9] The Official Records (OR) 1864 provide enough detail to construct field Daniell Cell batteries

Wire Transmission Systems

There are at least two ways to transmit a telegraph signal between stations if we are thinking about historical 19th century accuracy. One method used two wires between stations. That method is referred to in some literature as a metallic telegraph. The other system used a single wire between stations. The metallic telegraph works fine over short distances, but can become a problem over the long haul because of the resistance in the wire. The single wire configuration does not suffer so much from the resistance problem when the stations are far apart, but does require a good ground at each terminal station and does have resistance issues when the stations are closely spaced.

According to the book by Shaffner, the wire used between the stations was stranded galvanized steel. Insulation was non existent, paint, or among other things a substance called gutta-percha. Researched references revealed that the wire size was anywhere between number 6 and number 13 Birmingham Wire Gauge. Finding that kind of wire today is virtually impossible. That means that precise historical accuracy is also virtually impossible and a compromise is needed to reproduce 1860's telegraph station-to-station wiring. An acceptable solution could be to use nearly any kind of modern wire that will withstand pole tension or direct burial and tolerate the voltage and current without too much loss. Several people are using World War II commo wire, and it is reported to work just fine. Another alternative is black THHN stranded AWG 14. The resistance per 100 feet is fairly low, and it will withstand pole tension as well as direct burial.

Installation of the wire involves more attention to safety than anything else. We need to do what is necessary to achieve a safe installation for reenactors and spectators alike. Where possible, keep with the wisdom often expressed by people in other parts of the country and elevate the wire well above the crowd using any means available. Trees, lodge poles, or buildings could be common mounting points for the wire. Insulators are great additions, but consideration should be given to ensure they are period type or reproductions of period insulators. Burying the wire is also an option, although care needs to be taken to avoid escapes (grounding) and trip hazards.

The "telegraph" pole installation can be a problem in some areas. Some land owners don't like to have holes dug on their property, but most accept the use of stakes. Consider using telegraph poles that are lashed to a fence post driven in a foot or so prior to pole installation. Because of the way the pole nestles into the post, the end result is that the pole looks like it is buried, stands up well and tolerates an installed wire, at least for a three or four day event. Removal is a snap, just take off the pole and pull up the post. The hole left behind is small like a stake hole. Most land owners seem to think it's acceptable.

Grounds are an essential part of the terminal stations if the metallic telegraph is not used. There are many references that detail how to install a good ground system and what a ground system really is. The answer to what a ground system is and how it works is not necessarily intuitive, therefore some reading is recommended to fully understand what is going on. Grounding rods used are typically four to eight feet in length. It is necessary to contact the event organizer and/or land owner for permission to install wire and grounds. Finally, it is necessary to ensure all wire and ground rods are removed after each event, which is probably a good thing since most site owners insist upon it. Ground rods are available through many DIY stores selling electrical parts.

RF (Wireless) Transmission System

This section addresses an alternative to wire for the telegraph transmission system. Departing for wire is a movement away from authenticity, a movement we need to avoid if at all possible. However, there may be circumstances where it becomes necessary to use another solution in lieu of the wire. That could occur because the property owner does not want poles installed or wire strung. It may also occur if the field commanders will not use wire. It could also happen that we just don't have the time to put the wire up and take it down. Installing the wire and removing it can be difficult. It could take a day or so in advance of the event to put up, and an almost equal amount of time to take it down. It's a lot of work especially for a short event. One solution appears to be employing RF (radio frequency) for the "wire."

The RF solution recommend if the wire cannot be used include using a system that replicates the Morse Telegraph Club's (MTC) Dial-up Morse[10] system. The reason for the MTC Dial-up solution is recommended is because it solves the problem related to the operation of the key shorting switch where other solutions do not. Using the MTC solution, the telegraph system operates just as it did in 1860. A set of data radios operating in full duplex mode or cell phones substituting for the hard line phone service will be necessary. The radios or cell phones are fed with modems attached to each station through a terminal unit. The terminal unit is a device that generates polar DC for the modem when the key is opened or closed. Latency (delay) between phones exists with cell services, but does not pose a problem. Either way, duplex communications takes place and the telegraph stations act exactly as they do with wire. See references for terminal unit construction and dial-up operation. A description and diagram of the terminal unit is shown at Appendix 2 of this manual.

Power supplies for the radios/phones, the terminal units, and the modems are necessary. This can be easily solved using something like a deep cycle 12 volt battery connected to a pure sine wave inverter. You can place all the electronics in a "period" box located a few feet away from the operating table.

The wireless system for each station consists of the following:

- Trump-Raven modem interface
- Tandy 300/600 baud modem
- Telephone patch
- Switching unit
- Full duplex transceiver
- Power distribution system
- Radio power supply
- Local loop power supply
- Antenna

[10] Morse Telegraph Club Dial-Up Telegraph system has been in use for several years.

- 120 VAC supply system

The entire system operates just as if there were a wire attached. Thus telegraph operation authenticity is preserved. If cell phones are used operating costs might be incurred because you are using commercial services. If you elect to use data radios, licenses may be necessary. If you place all the modern equipment in a "period" box, the operation becomes transparent to visitors. What you have built is a cell phone or data radio version of the Morse Telegraph Club's Dial-up Morse using the Trump-Raven 2 Wire Solid State Dial-up Terminal. With the Dial-up Morse system, you can operate at most any code speed accurately using the key lock just as if a wire were attached. Most cell phones pass the telegraph pulses through the analog or digital audio channels with modems operating at 300 baud. The modems and telegraphy are slow enough that the packet package passes through the audio circuits unaffected.

If there is no cell phone service to the remote location, then data radios are necessary. Assuming the Amateur Service will be employed, two meters and 70 cm in duplex mode seems to work fine. The procedure is just as it would be for the cell phone. The caveat is the station ID is necessary every 10 minutes.

Message Formatting - Word Counting

Several pieces need to fit together when preparing an "official" message using the rules that seemed to be in place during the war. We initially chose the Western Union Rules of 1866 as a standard. Others may agree that these were most likely used during the war especially by the UMTS. Turns out, the CSA operators were mainly American Telegraph folks, and they used very similar methods to format and record formal message traffic. That would make sense because they had to talk to each other over the wire prior to the war, so the systems and formats could not have been too different. The operators were after all from the same fraternity.

Upon close examination, it looks like the WU Rules were written around what people were actually doing in the field prior to 1866. When several pictures of telegrams were examined, at least two anomalies were discovered with respect to the rules that aren't very large, but worth noting. Both differences between the telegrams and the Rules involve word counting and recording.

In 1866, the Rules seemed to indicate that additional charges for messages forwarded by WU would be levied. Those charges were the amount necessary to cover the word count in the preamble. In all the messages reviewed, it was not discernable where that additional charge was applied between 1855 and 1865. Also, in all the telegrams reviewed where a word count was evident it was based on the message text only. The other difference was that for military telegrams, no charge seemed to be levied for anything both for USA and CSA. Moreover, in many cases no word count on military telegrams examined was evident. It may be that the original telegram was examined, not the copy that was sent. If it proves to be the case that word counting was not done for military telegrams, it could mean that they were shooting messages off into space and they didn't care too much about the accuracy. That is difficult to believe, but may be accurate because there were errors, some deliberate. If the word counts were not transmitted in military telegrams, they were certainly recorded on the receiving end. There are numerous accounts where each quarter a summary of telegraphic activity was submitted to superiors. That summary included message word counts, numbers of messages transmitted, and numbers of messages received. The other observation is that the WU rules didn't seem to use word counts for error detection as much as for tariff gathering. On commercial lines, money was the name of the game. Apart from those two anomalies, the Rules of 1866 generally seemed to be in play for both the North and the South. In all cases what was observed including notes in the margins, the spelling of numbers in the text, and the word count for the text seem to be in tune with the WU Rules of 1866. As it turns out, they were the same procedures alluded to in a book by Prescott written in 1860.

A typical message is divided into five pieces. The first is the preamble, followed by the "to," then by the text. Next are the signature ("from") and finally the message management indicators. Once the word counting is understood, the rest of the Rules as printed seem very straight forward.

The example used is from the WU Rules page 12.

The preamble is made up of the telegraph company/organization announcement along with the date and place the message is originated. The banner at the top of the telegram blank provides the organization, such as the United States Military Telegraph. This part of the telegram or message does not get transmitted or word counted. The next part of the preamble does get sent. Please note that the origination location of the telegram may not necessarily be the same place as the transmitting station. For example:

Buffalo, Oct. 10th, 1865.

This message originated in Buffalo on 10/10/1865 but was transmitted from Rochester. The preamble counting is a bit strange, but it is shown here to provide an idea of what they sent and how they counted words in the preamble. We will not count the preamble for our impressions. According to the Rules, there are seven "words" in that preamble. The only way that is possible is to count punctuation, an unusual occurrence.

1. Buffalo
2. ,
3. Oct
4. .
5. 10th
6. ,
7. 1865.

As part of the preamble, the message number was sent, but not charged for. That means some sort of a sequential numbering system was used. The numbering was restarted each day. Also, the last period was not charged for, as it was a separator.

The "to" is not word counted, but sent. In the example:

John Brown, Geneva, N.Y.

Note again the use of punctuation. The commas are significant as is the period. The Rules note that a period is always inserted after the last of the "to" prior to the text as a separator. Today, we might insert BT or break rather than a period. There were still a few offices using printing machines and registers, so the BT would not have been necessary and a period would have worked fine. The commas are discussed later.

The text in this example is:

Meet me here next Monday, at 10 o'clock in the forenoon.

There are eleven words in the text. They are:

1. Meet
2. me
3. here
4. next
5. Monday
6. at
7. ten
8. o'clock
9. in
10. the
11. forenoon.

Note that punctuation is not counted as it was in the preamble. Again, after the text is sent, they added a period for a break.

The signature is sent but not word counted.

In the example, the signature is H. Smith.

The last part sent is the word count, station origination, the tariff and other message management indicators. Note there is a period inserted after Smith, remembering that a period is like a break or BT.

In this case:

18 Rh 64 pd if we are counting the preamble. If we don't count the preamble, the last line becomes 11 Rh 39 pd, where 39 would be the charge. Since in our impressions we are doing "free telegrams," unless we want to make a few bucks on the side, we would eliminate the tariff part, or just put free, as they might have done according to the Rules. Using that premise, the last line would be: 11 Rh free. It's interesting again to note that today, when telegrams are sent in the American Radio Relay League National Traffic System, and as described by the Morse Telegraph Club people, the word count and tariff information was sent as part of the preamble. From what has been observed looking at the telegrams, telegram blanks, and the WU Rules, it was sent at the end. All that means eighteen words (or 11 words) transmitted from Rochester. They paid 64 cents for the message. Reviewing telegrams in the CSA arena, the notation for word counting and application of tariffs was a bit different. Perhaps it's what they did on the American Telegraph lines. Using the example above, the notation would have been something like "18/64 col", meaning there were 18 words and to collect 64 cents at the receiving end. Typically, in the CSA example, the sending station was listed next.

Once we understand how numbers and punctuation is counted, word counting is pretty straight forward. The Rules explain what a word is and how numbers are counted. Remember that a great deal of the message management is done in the margin of the message, and much of that management information is transcribed onto a blotter, or register. Because message management is done right on the message, recording in the record books can be done later at a more convenient time.

Now for some observations. First, the old guys seem to spell out nearly everything. They used few abbreviations. In fact, they spelled out the numbers, as we might today. They did use station call signs in the message management portion of the telegram. Also, the uses of either the "92" code[11] a couple of times or the WU reply request code were evident. In our example case it was the number "33" which means deliver only to the person addressed under the newer 92 code or wait for a ten word response under the WU reply code. Either would have been applicable in the messages reviewed. The "33" was coded in the margin, and would have been sent in the last line with the word count information. Interestingly enough, the 92 code talked about in the Shaffner book written in 1859 describes the number 33 as "answer paid here." So, if we apply the WU rules, we are close to the mark for accuracy. Another observation related to the time of day. The time of day may have been recorded in the margin, but not sent. Later (after 1900), examples where the time of day was sent was evident.

According to a former Western Union operator, and reading some information from the Morse Telegraph Club, another symbol was added to help with the "to" part of the message. After each line in the "to," the symbol "a a" was added by an operator. Today we still add the symbol "a a". It really isn't "a a" however, it's a comma in (American) Morse. Hence we see the use of commas as separators in our examples. If we were doing messages by sound, as most of us do, add the "a a" rather than a comma if using the Continental Code after each line in the preamble for separation.

There may be some concern we will take too much time to send an official message using this WU method. That may be true during an operator's learning curve, but once you get the hang of message traffic using the Rules, things should move along quite fast. According to Prescott, an experienced operator can pass messages at the rate of 25 words per minute, each message containing an average of ten words.

Recapping, our standards in priority order are:

1. Use Western Union Rules for official messages
    a. Use aa as a separator in the address lines
    b. Use word counting for text only
    c. Number the telegrams
    d. Record telegram number, number of words, date and time in daily "blotter."
    e. Keep copy of all official messages
    f. Designate station and operator call signs
2. Use 92 code for intra station communications

[11] The copies of the 1859 Western Union 92 Code available lists 135 code numbers. The original code is not available.

Telegraph Codes

During the 1860's there were several codes used to send messages over the telegraph lines. Two principal types dominated. The "mother tongue was Morse, known today as American Morse. The Continental Code, or International Morse, was in use on the circuits outside the United States. Those who learn the code today typically learn International Morse. For our purposes, the standard is Morse, or American Morse. If the only code two opposing operators know is the Continental Code, then we can accept that as an approved alternative.

Much has been made of using the Meyers Dot Code, or the General Service Code as a means of communication on the wire. There is no evidence that the Dot Code or the General Service Code was ever used on the wire in either the North or the South. Therefore, it will not be used on our wires.

Use of codes and ciphers is allowed providing they are period codes. Also, the use of abbreviations is allowed as long as they are of the period. For example, the 92 Code would be allowed where "Q" signals are not.

Safety Considerations

As reenactors and living historians, we need to do what is necessary to provide a safe environment for ourselves as well as the patrons who visit our sites. In addition to general camp and site safety, three items need to be addressed specifically related to the telegraph:

The wire

1. The telegraph wire needs to be installed such that the visitors and those not associated with the telegraph are shielded from any contact.
2. The wire needs to be elevated when ever possible. The use of trees, poles, and buildings are a good choice. The wire should be at least eight feet above the terrain when suspended if no horses are used at an event. If horses are used, the elevation needs to be at least 20 feet.
3. Insulators are acceptable for use, but the wire on the insulator must be secure so that it will not slip over time and sag into the path of people and/or equipment.
4. The wire may be buried, but it must be installed such that people or equipment walking or rolling over the wire will not disturb it from its location causing a trip or tangle hazard. This includes animals walking over the wire. Wire should be buried at least four inches deep.
5. The wire must be insulated. THHN is both water and grease resistant, making it a good choice. All splices should be well covered with electrical insulating tape.
6. When wire is used, all commanders need to be briefed on the wire location and installation technique used.

Power Sources

7. The power supplies for the mainline provide at least 60 volts DC. The points where the voltage is exposed typically includes the key, relay, and the distribution block on the table. Those exposed voltage points must be shielded from unauthorized persons by mechanical means or through distance restrictions.
8. The power supplies must not be exposed to the elements or be in a position where unauthorized access is possible.
9. Ground rods are used at terminal stations if a metallic telegraph is not employed. The ground rods need to be placed such that unauthorized access is prevented.
10. Power on the tables will be turned off when any table on the line is unattended.
11. All power supplies will be fused.
12. Current on the line will be 50 ma. nominally, but not exceed 100 ma. Current will be limited by ballast devices or resistors.

Chemical Batteries

13. Chemical batteries must be shielded from access by unauthorized people. This can be done by mechanical shielding or through distance restrictions.
14. Chemicals used in the batteries are limited to Copper Sulfate, Zinc Sulfate, and Sulfuric Acid. In all cases, the precautions listed on the appropriate MSDS sheet will be followed.
15. People using the acids in the chemical batteries will have and use appropriate PPE as defined in the MSDS for the acid in use.
16. Unauthorized people will not be allowed within 10 feet of operating chemical batteries.
17. Everyone working with chemical batteries must have read and understand the MSDS sheet for the acid in use.
18. An acid spill kit will be available when acids are in use.
19. Event organizers and on-site medical personnel must be aware of the presence of chemical batteries and chemicals used.

Period Dress

Wearing the proper clothing is as important as having the correct equipment available and using appropriate codes. Many authenticity guidelines exist for period dress. The guidance that most closely matches our unit is expressed by the Signal Corps Reenactor's Service Manual. In general, the telegraph people for the USA were civilians. There were some enlisted people and officers serving with the telegraph people in the USA, but they were attached to the Quartermaster Corps and Secretary of War. There were exceptions like Thomas T. Eckert and Anson Stanger. They were assigned to the Secretary of War. The telegraph service was not part of the USA Signal Corps. Telegraph people for the CSA were in the military service assigned to the newly formed Signal Corps. They had both enlisted and officers assigned to the Corps. In the CSA the Signal Corps not only took care of the telegraph, but performed duties with flags, torches, couriers, rockets, and ciphers.

Reenacting and Living History

Our hobby is Living History which is portraying a period of time as accurately as we can and doing it with integrity. We are making the education of the public our responsibility. We do it voluntarily; in fact we sometimes pay to do it! It is our duty to present the facts, not the stereotypes. Therefore we must do the research necessary to dig up those facts; and present to the public the most historically accurate image possible. We can truly honor those ancestors we represent by getting their story right.

Civil War encampments are designed as a vehicle for teaching American History. The public who attend our reenactments are intelligent people and many are Civil War buffs. They can spot an anachronism, such as a cooler, a can of soda, a wristwatch, or a sleeping bag, quite readily and are quick to comment. When the public walks through an authentic encampment and sees these kinds of modern intrusions, they doubt the validity of the camp as a whole. To have these intrusions spoil the impression is not fair to the visitor who may have paid to enter our camp. Neither is it fair to the others in the encampment, who work very hard at maintaining an authentic 1860's environment. So when you prepare for an event, if an item is not a true representation of the period, don't pack it. Do your best to keep your impression period correct.

When you put on your frock coat or hoop-skirted outfit, you become a window to the past for the visitors at our reenactments. It is your duty to provide a clean view through that window. If you don't put in the effort to research the details of your 1860's persona, your characterization will be like a window covered in dust. The historic image that the visitor sees is warped and incorrect. Then you have done a disservice to that visitor and to the peoples of the 1860's whose history we are trying to teach.

There are a number of things you should know before you pull out your wallet. Unfortunately, there are no standards for the merchandise available on Sutlers Row. Some sutler's carry "old looking" clothing that is not necessarily correct to the era of the Civil War. A few carry garments and accessories in prints or colors that were not available at the time. Not to mention items made of polyesters and plastic. So unless you do the research first, you may end up spending a lot of money on inappropriate items.

Before you invest a lot of money in clothing and accessories, spend a good amount of time talking to the members of the club who have been doing this for a while. There will be many tips and suggestions to be heard. Many of us have spare garments that we are willing to loan for a few events while you decide on a persona. Everyone is willing to be helpful so don't be afraid to ask a lot of questions.

Know Your Role

Five Tips for selecting and researching a beginning role

Tip No. 1 Find a Mentor

Talk with some of the established members. They can help at your first few events by lending you clothing and accessories, sharing tent space or incorporating you into their portrayal for a few events. This is an easy way to learn the ropes until you decide which direction you want to take.

Tip No. 2 Keep It Simple and Straight Forward

Before you spend tons of money on clothing and gear, go to a couple of events in a simple role. Test the waters as it were, by portraying a general role where specific action is not immediately required. Be a helper to someone with an established role and learn by watching.

Tip No. 3   Portray What You Know

If you have a skill you enjoy and would like to share with others, check out its history in connection to the Civil War. Many of today's visitors to our living histories have never seen anyone portray 19thy century living using replica or real equipment.

Tip No. 4   Do Lots of Research

Research is a treasure hunt. It's your job to dig up the gold that you will use to create your persona. Sure you can pick up a musket or grab some hard tack; but think how much more you can teach people if you can talk about the effects of the weather, the effects of insects on you, the effects of the economic times, and the morale of the troops.

The more background information you have on the character you portray, the more realistic and three-dimensional you will become in your role.

Tip No. 5   Read About Social History

Many long time re-enactors are quick to make remarks that are stereotypical rather than true. A woman was not an old maid if she was unmarried at 18. Not everyone wanted a beard. Not everyone was religious. Vice was common and not always illegal. Most people were literate and with much better vocabularies than we use today. Most women worked farm, factory or cottage industry. People with slaves or servants were a minority of the population. The North was not a united front. Many Northerners did not support the war and worked to further the Southern cause. Not every Northerner supported or liked President Lincoln. Don't present your persona in a vacuum. Learn some of the social background of the mid Victorian era.

Apart from the combat roles, there are many ideas to consider for non-combat roles for both men and women.

A great deal of the information was captured from:

http://www.shasta.com/suesgoodco/newcivilians. This web site focuses on civilian and women, but the themes apply to all living historians. Also see: http://www.racw.org/. This is a California group that has a great deal of information about reenacting form a combat point of view. This site: http://www.ovcwa.org/ is a terrific place that shows how they do living history in Ohio. As it turns out, there are several sites specific to the activity you may want to associate with. The challenge for you is to find the places to begin your research.

One final word. Cost. This hobby like many other can wind up costing a great deal. You will not have all the goodies at the start, but over time, if you stay with the hobby, you'll find spending will be comparable with most other hobbies. It usually takes about a year to get your gear together, so take your time, do the research first and get good stuff. That is the best way to save time and money. Don't get sticker shock as most things can be delayed and/or alternatives found. Do not be fearful of using your imagination and be resourceful.

APPENDIX 1

Morse Telegraph Circuits for Re-enactment Events
By L.E. Trump

Much experimentation has been done in regard to determining what would be suitable arrangements for Morse telegraph circuits that could be set up and used during Civil War era re-enactments and similar activities.

There were several criteria that were deemed necessary to follow for such circuits:

1. The circuitry should be of a type that is as similar as possible to what might have been actually used in the mid 1860's, i.e. ground return, single wire.
2. Instrument types should be similar in construction and coil resistance value as those actually used during the era, i.e. Morse relays, 150 ohm coil windings.
3. Power sources should be electrically equivalent to that available in the 1860's period, but safe, operationally practical, and dependable.
4. Minimal hazards to people, property and animals, and minimal environmental impact on the locations of the activity.

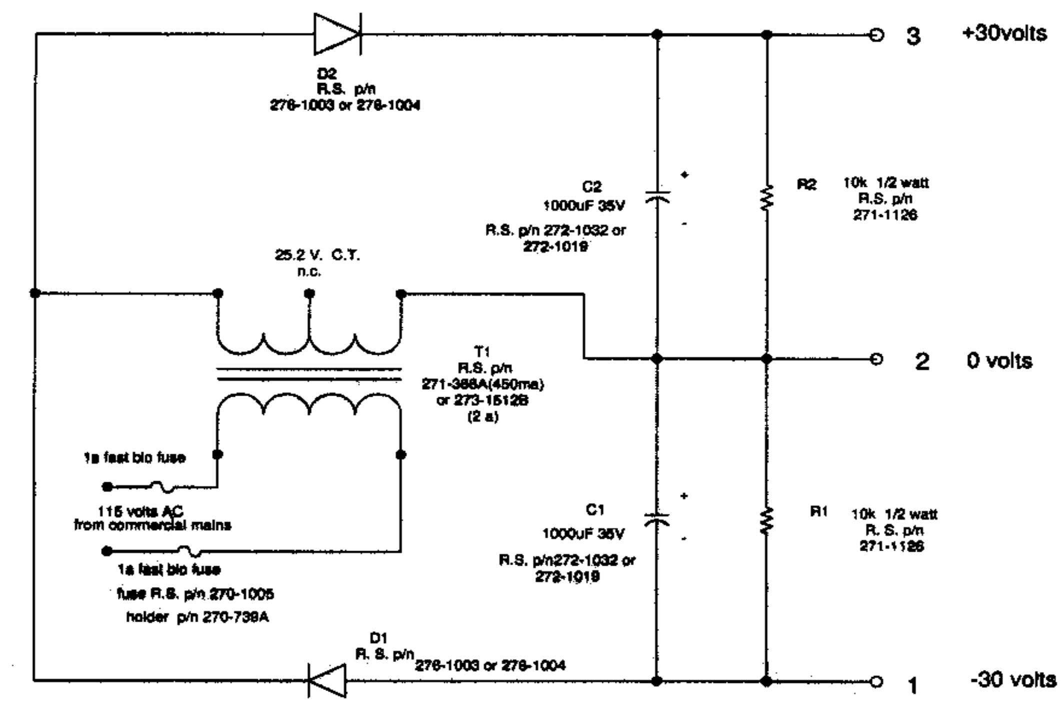
With these criteria in mind, experimentation was carried out by means of actually constructing and testing a circuit to see how well it operated.

Ground return telegraph circuits using a single wire conductor insulated from Earth, have some characteristics that are useful in this work. For a physically short circuit, say less than a few miles, the resistance of the circuit is dominated by the path through the earth. This may be partly due to imperfect ground connections, the rudimentary electrodes used for grounding purposes. This situation can be used to advantage, especially for "shorter" circuit lengths of a few hundred yards to a couple of miles or so.

For these high resistance circuits, we are forced into using low current values. Because of this, we must also use high resistance (what are commonly called "main line") telegraph instruments, wound with coil resistances of 120 to 150 ohms or so. The reason for this is simply because we cannot safely force enough current through such a high resistance circuit to operate low resistance (4 or 20 ohm etc.) relays or sounders. It would take unsafe voltages to do so. The high resistance instruments are designed to operate reliably on line currents of 50 milliamperes or so with limits of roughly 30-60 Ma. These current values can be easily obtained in a grounded, single wire circuit without the use of hazardous voltages at the power supply.

The experimentation that has been done was initially carried out with a transformer-rectifier-filter power source connected to the commercial AC mains, and utilized an auto-transformer (Variac) to allow adjustable power supply voltages. This was used to explore the range of voltage which would be necessary to operate a grounded circuit of considerable length, and with makeshift ground electrodes.

UNIVERSAL TELEGRAPH POWER SUPPLY



Notes

This power supply can be connected with terminal 1 to Earth, giving +30 volts at terminal 2, and +60 volts at terminal 3.	Or, it can be connected with terminal 2 to Earth, giving -30 volts at terminal 1, and +30 volts at terminal 3.	A third possible way it can be connected is to connect terminal 3 to Earth, then terminal 2 will be at -30 volts, and terminal 1 will be at -60 volts.	The AC transformer winding should be equipped with an appropriate line cord and plug. Do NOT overfuse. The 1 amp fuses will carry the supply at full output.

A 40 watt, 120 volt lamp, such as a tubular style, or appliance lamp, should be connected in series with all outputs of this supply except the earth-connected one. This lamp will provide isolation between multiple circuits "taking battery" from it as well as provide adequate short circuit protection in case the supply is inadvertently grounded or short circuited close in to the output. The filament will remain dark unless the current reaches approximately 90 mA, at which point it will begin to glow. A full short circuit will light the lamp to about half brilliance, and limit the current to about 150 mA.

A test circuit was constructed using a large spool of insulated, 22 ga. tinned copper hookup wire, three 150 ohm Morse relays, telegraph keys, and ground electrode consisting of a short iron rod pushed a couple of feet down into damp moist earth. The large spool of wire procured for the experiment was 3300 feet of four conductors, splices being made at the ends of the spool so as to form one single conductor 13,200 feet in length, which is approximately 2 1/2 miles. the conductors were connected in series in such a fashion as to eliminate inductive effects by cancellation. That is, the current transits the spool of wire four times, twice in each direction, thus effectively cancelling any inductive effects that may be due to the wire being all wound on a large spool. I did not have enough room available to string it all out in one length.

The experimentation began by connecting this spool of wire in series with two 150 ohm Morse relays, a 120 volt 40 watt incandescent lamp, and the Variac adjustable power supply. Earth at the power supply end was "Power Neutral". The "far" end of the spool of wire was connected to a third 150 ohm relay, and then to a two foot 3/8 inch diameter (rusty) steel rod, pounded down into the soft ground at the rear property fence, fifty yards or so out in the back of the house. The end result was a Morse circuit with two instruments and "Battery" at one end, ground and a third instrument at the "far" end 2 1/2 miles distant circuit-wise. The 120 Volt 40 Watt light bulb was included as a protection device, to prevent damage in case the circuit was inadvertently grounded too close to the supply end. The filament remains dark in such a lamp until the current approaches about 90 Ma, and its series resistance with a dark filament is negligible in the circuit. It was and is good practice to include such a lamp in ANY rectifier/filter type power source used for telegraph work.

The circuit would not operate at all until the voltage was increased to about 40 volts, as measured with a switchboard voltmeter (11,200 ohms meter resistance). At this point, the the circuit closed weakly with about 20 Ma flowing. The instruments could be adjusted to work with this, but were near the extreme end of their range. Once adjusted however, the circuit was entirely workable in all respects.

The voltage was raised until the circuit current was 55 Ma. This resulted when the voltage reached approximately 60 volts. This is an adequate, but "non-hazardous" value of DC voltage, and the rest of the experiments were carried out with this as a limit for terminal voltage supply. Higher voltages up to about 130 volts were tried, but this only resulted in higher current in the circuit, and extra series resistance needed to be added to keep the current near the 50 Ma desired value. More than 60 volts therefore, was unnecessary. The 40 to 60 volt open circuit battery voltage was more than adequate to properly operate the circuit with three or four 150 ohm instruments cut in.

The circuit length was varied by changing how much of the wire on the spool was included in the circuit. It was found that the circuit current only varied a few (less than 5) Ma. when 1/4, then 1/2, then the ENTIRE spool of wire, all 2 1/2 miles of it, was cut out. From this, it was indicated that the resistance in the circuit contributed by the ground path was dominant. For all practical purposes, in this particular situation, the LENGTH of the wire conductor in the circuit was immaterial. This means that with this circuit, it would be possible to work from a few yards to over 2 miles without doing anything to the voltage or current at the supply.

This is an ideal setup for a re-enactment activity, as it would make establishing and rearranging circuits to various "offices" fairly simple. The circuits could all "take battery" at one central point, and all that would be necessary at the distant end would be a simple ground connection of some kind. Shortening or lengthening of lines could be easily done by simply relocating the end of the circuit and its ground connection. Additional offices could be "cut in" at any intermediate point along any line without disturbing the circuit values to any appreciable degree.

A different power supply was devised, that has fixed output voltages, and can be connected in a variety of ways to supply "Telegraph Battery" for this kind of circuit. See Fig. 1. This power supply uses readily available parts from Radio Shack , and is designed so that it can be plugged into a GFI AC outlet and be safely used for grounded telegraph circuits. The supply may be connected with Earth and provide both positive and negative 30 volts, or can be connected to provide either positive 60 volts or negative 60 volts with respect to Earth. 120 Volt , 40 watt lamps should always be connected in series with the power supply outputs and the telegraph circuit for safety reasons already noted.

Ground connections were also experimented with. The simple driven rod proved adequate in moist earth. A rifle bayonet would also work as well. A chunk of wire screen was attached to a wire and tossed into a large mud puddle nearby. This also allowed full line current to pass. Other things tried were a keyhole saw blade shoved into the earth. a steel fence post. etc. All seemed to work effectively.

Other "grounds" that can be considered would be railroad rails, well casings, large metal building frames, driven pipes or rods, buried plates or metal cans, or coils of bare wire, etc. The simplest, and perhaps the most overlooked possibility, is a river, creek, pond, or other body of water. A few yards of bare wire, or a wire attached to a large chunk of metal screen can or bucket, sunk in such a body of water will provide a nearly perfect ground, and be extremely environmentally friendly. No trace of its use remains when it is removed and hauled away.

The end result of the experiments show that it is possible to erect simple telegraph wires in the traditional fashion, and operate them at almost any distance apt to be encountered in a typical re-enactment activity, with simple power sources of fairly low, non-hazardous voltages. The line wires of course must be insulated as perfectly as possible from Earth, but it has been shown that the circuit length is mostly immaterial even with smaller size wire as long as the battery voltage is sufficient. Since but a single wire is required between "stations" or "offices", the circuitry is simple and straightforward. Instruments can be the more common high resistance "mainline" types that most people have in their collections. Ground connections can be rudimentary and easy to establish. "Battery" can be supplied at one end or both ends of the circuit, as circumstances dictate.

The one other aspect that needs to be addressed is lightning protection. Any time a wire is strung for any length out of doors, it becomes a prime target for lightning strikes. Any such telegraph wire should be, at MINIMUM, provided with simple, air-gap arrestors, such as those provided on peg-strap switchboards, or simple cut-outs with air gap protectors., and a ground electrode at each station or office. The air gap type is adequate in most cases, although NOTHING will protect against a direct strike.

In any event, make sure ALL instruments are DISCONNECTED entirely from the circuit during any nearby electrical storm with visible lightning, and stay away from working on poles, lances or other outside parts of the line during such storms. For safety's sake, ground the wires at all stations until the storm has passed on.

Ed Trump, Fairbanks, Alaska April 1998.

APPENDIX 2

HOW THE SOLID STATE MORSE TERMINAL UNIT OPERATES

By Ed Trump

It may be of help to study the exact operation of the various parts of the solid state terminal circuit. This information will be valuable for trouble shooting a terminal unit that is not working properly. The following discourse assumes that a call is already connected and that a dial-up session is in progress, with the modems at each end of the telephone circuit properly passing the AFSK (Audio Frequency Shift Keying) signals between them. Refer to the schematic diagram of the solid state Morse terminal unit shown at the end of this document. The received Morse signal from the distant dialup office is converted by the modem to a "polar" dc voltage that appears on pin 3 of the EIA 25 pin modem connector. This voltage is about 10 volts negative with respect to common (pin 7) when the far end key is closed, and about 10 volts positive with respect to common when the far end key is open. You can measure this at pin 3 with a voltmeter. This polar voltage change is applied to pin 2 of U1A, which is part of the dual solid state operational amplifier chip. In this case the U1A section is used simply as an inverter and the output at U1A pin 1 is opposite in polarity to that of the input applied to U1A pin 2. That is, when the voltage at pin 2 of U1A from the modem is "positive", the output at pin 1 of U1A is "negative" with respect to circuit common, and vice versa, when the input at U1A pin 2 goes "negative", U1A pin 1 goes "positive. The polar voltage output of U1A pin 1 is applied via a 2.2k ohm resistance to the base of the loop keyer transistor Q1. Notice there is a 1N914 diode connected from the base of the keyer transistor to common. This serves to prevent the voltage presented at the base of Q1 from going very far in the negative direction. If it were allowed to, it would destroy the keyer transistor. The 2.2 K resistor acts as a load for the output of the op-amp U1A, and when the voltage at pin 1 goes "negative" the diode across Q1's base shunts it to common. When the voltage at U1A pin 1 is "positive" it causes Q1 to saturate, and closes the loop circuit from collector to emitter, the emitter being tied to common. Q1 is then just acting as a switch in the loop circuit that is controlled by the incoming signal applied to its base after being processed to the proper polarity by U1A.

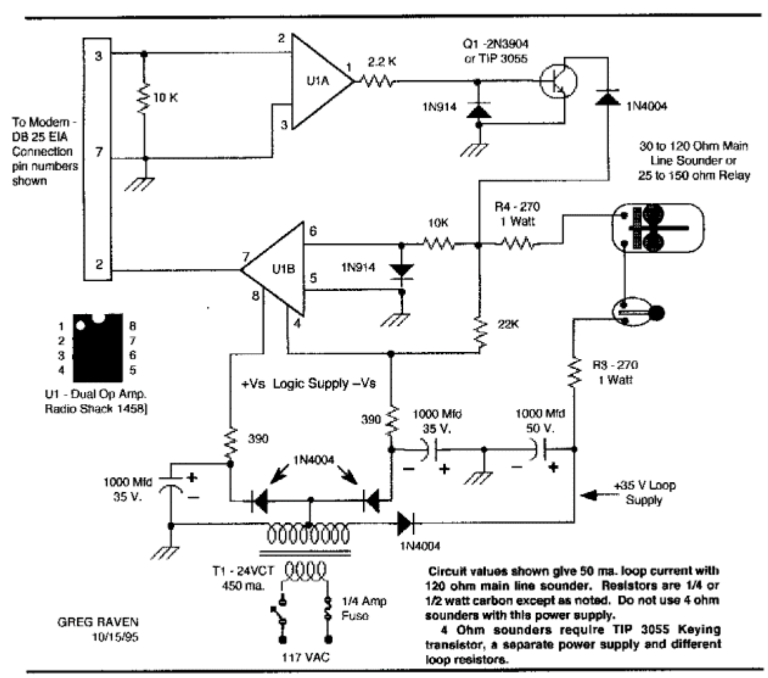
Although not shown in the diagram, there should be a diode connected "in reverse" (that is, diode cathode to collector, diode anode to emitter) across the collector-emitter pins of Q1. The purpose of this reverse connected diode is to shunt to ground (when Q1 opens the loop) the reverse current produced by the collapsing magnetic field in the telegraph instrument windings. The high resistance mainline telegraph instruments most of us use with these converters has a large reverse current kick when the circuit they are in is opened, so we need to protect Q1 from being damaged by it. That is what this diode is for. The circuit will work without it, but Q1 may be destroyed at any time by a reverse current surge, and it is best to include this protection diode to prevent any possibility of it. Look at the circuit from the collector of Q1, and you will see there is another diode in series with the telegraph loop circuit. This diode plays a critical role in the prevention of "reflections" or "kickbacks" from the terminal back over the circuit to the distant office. In the loop circuit, as long as the telegraph key is closed, "positive" loop voltage supply is connected via the key, sounder coil windings and loop resistors thru this series diode to the collector of Q1. When Q1 is conducting and holding the loop closed, there is about 0.7 volts drop across the collector/emitter junction of Q1, and also there is about 0.7 volts drop across the series diode in the loop circuit. With loop closed and current flowing, then, there is about 1.4 volts "positive" at the junction of the series diode anode and the loop resistor in the telegraph loop. When Q1 opens the loop circuit, current flow ceases, but the voltage potential at this junction of the loop resistor and the series diode anode rises to the value of the loop supply voltage. As long as the key in the telegraph loop remains closed, the voltage at the junction of the series diode and the loop resistor ALWAYS remains at some "positive" value. It fluctuates between about 1.4 volts "positive" when the loop is closed to about 25+ volts "positive" when the loop is opened by the keyer transistor Q1, but always remains "positive" in potential with respect to common. You can measure this voltage fluctuation with a voltmeter. We use this constant "positive" voltage to "clamp" the transmit portion of the terminal set in the "mark" or "closed circuit" state back towards the distant office by sampling the voltage via a 10k ohm resistor that is connected to pin 6 of U1B. Notice there is a 1N914 diode also connected between pin 6 of U1B and circuit common. This diode clamps the positive voltage sampled from the loop via the 10 K resistor to no more than about 0.7 volts "positive" regardless of whether the local telegraph loop is opened or closed by Q1. As long as the telegraph key in the local circuit is closed, the voltage at pin 6 of U1B will never vary from about 0.7 volts "positive". You can measure this with a voltmeter. Pin 6 of U1B is the "inverting input" of the "B" opamp section of U1. Pin 5 of U1B is hard wired to common and remains at "zero" volts all the time. The voltage at pin 6 of U1B then controls the output of U1B at pin 7. When the voltage at pin 6 is at "positive" 0.7 volts, the output of U1B at pin 7 is about 10 volts "negative" with respect to common. This "negative" voltage is passed to the modem via pin 2 of the EIA 25 pin connector, and results in a "closed circuit" or "marking" tone frequency being sent to the distant office. This should ALWAYS be so unless the local telegraph key is opened. The voltage at U1B pin 7 should NEVER vary from about "negative" 10 volts or so when the set is receiving from the distant office, and the local telegraph key is closed.

When the local telegraph key is opened, the "positive" telegraph loop supply voltage is removed from the loop circuit. There is a 22k ohm resistor connected from -Vs (about -12 volts, Integrated circuit supply) to the junction of the loop resistor and the series diode discussed above. This serves to drive the voltage at pin 6 of U1B hard in the "negative" direction when the local telegraph key is opened. With a "negative" potential at pin 6 of U1B, it's output at pin 7 goes to about 10 volts "positive." This transition from "negative" 10 volts to "positive" 10 volts is the "polar" EIA signal that is passed via pin 2 of the modem 25 pin EIA connector and is what causes the AFSK signal being sent towards the distant office to change from "marking" to "spacing" and so on back and forth between the "closed circuit" and the "open circuit" state. So, as the local telegraph key is opened and closed, the output at pin 7 of U1B towards the modem is controlled in response to the Morse being sent by swinging from minus 10 volts to plus 10 volts.

Some other information about the operation of this circuit… Notice that the telegraph key controls the transmit portion of the circuit regardless of the state of Q1. This provides a means of "break-in" to alert the distant office that you have opened the circuit. When you hold your key open, the distant operator's sounder should stop responding cleanly to his own sending and after a bit of practice he will be able to recognize that you "broke" him. These sets do not really "break" cleanly. When receiving an "open" circuit state from the far end, the near end sounder will try to pull in but then falls open and does not follow the key correctly. Therefore, a little vigilance is necessary to detect the "break" from the far end. If you are working into a hub dialup repeater, some hubs will return a "reverse" to the sending operator when someone on one of the legs on the opposite side of the hub "breaks". Again, a little vigilance will be required to recognize this and close your key to allow the breaking operator to send. The sounder will keep clattering while you send but will not follow cleanly, so you need to watch for this and learn how to recognize it.

Morse Telegraph Club, Inc.

Trump-Raven 2-Wire Solid State Dial-up Morse Terminal



For information on this circuit contact Greg Raven, 11440 NW 27 Ct., Plantation, FL 33323
Phone 954-452-0087 - E-mail: gsraven@ieee.org