

Instructions for Cup Hook Station

Version 4.0

Updated April 7, 2021

- Added drilling diagram for mounting cup hook

Seth Neumann

Seth@modelrailroadcontrolsystems.com

Contents

Instructions for Cup Hook Station	1
Figures:	2
What's in the Box?	3
Cable and backboard Installation:.....	4
Installing Cuphook Phones	4
Connections with MRCS' Morse Code Buzzer Controller (MCBC).....	13
Relay Latch Connections	16
Off Hook Indication.....	19
Other	21

Figures:

Figure 1 - Cup Hook Kit.....	3
Figure 2 - Assembled Cup Hook Phone on Fascia.....	3
Figure 3 – Backboard to Station Cable Functional Assignments/Cat 5 Color Code.....	4
Figure 4 - Cup Style Hook Switch	5
Figure 5 - G3 (Non PTT) Handset.....	5
Figure 6 –425 (classic) and ITT 181427 (modern) Speech Networks	6
Figure 7 - Inside of Cup Hook	7
Figure 8 -Cup Hook Mounting Diagram	8
Figure 9 - Cup Hook Connections – lines in BOLD are required, others are optional	9
Figure 10 - Network Connection Table	10
Figure 11 - Assembled Phone from Back of Fascia	11
Figure 12 - Cup Hook Switch Phone Schematic.....	12
Figure 13 - Morse Code Buzzer Controller	13
Figure 14 - Morse Code Buzzer Controller Connections	14
Figure 15 – MRCS' Power and Ground Distribution Board	14
Figure 16 – Vellman SvM12N buzzer (12VDC)	15
Figure 17 - LED - Buzzer Parallel Combination	16
Figure 18 - Omron Relay Breakout	16
Figure 19 – Relay Latch Connections.....	17
Figure 20 - Latch Schematic	18
Figure 21 - LED installed on Cup Hook (courtesy of Tommy Holt).....	19
Figure 22 - EBF31A Version 3.1- Note relay in lower right.....	20
Figure 23 - Contact Terminology	21

What's in the Box?

We sell a Cup Hook Phone Kit consisting of a Cup Hook Switch, a Push to Talk Handset and a speech network.



Figure 1 - Cup Hook Kit

<http://www.modelrailroadcontrolsystems.com/fascia-mount-cup-hook-phone-kit/>

These parts are described in the following section. You can make your own kit using available parts and we can make you a custom kit if you need something special. For example, you might buy a 500 set at a garage sale and use the handset and network from the phone and purchase a cup hook. Standard handsets are wired the same as our Push-to-Talk handset. If you found a 554 or 2554 wall set, see our application note on wall phones.



Figure 2 - Assembled Cup Hook Phone on Fascia

Cable and backboard Installation:

Try to locate the system backboard somewhere central that has good access, good light (mount a light stick over it) with access to power. A power strip with a switch is helpful as then you can power the entire system on and off with one control.

Run one piece of Cat5 (or Cat5e, Cat 6 – but there's a lot of tight twisting to undo – or Cat3 works fine if you have any around) cable to each station. This makes for easier trouble shooting and allows for per-station features like LED indicators, buzzers, ringers and push buttons.

Bus the talk pair (tip and ring) to the white/blue and blue/white of each phone. You can use our telephone connector board or telephone style 66 or 110 style punch blocks or 8 position Jones Barrier Strips, I recommend one strip per phone if using Jones barrier strips. This allows for easy troubleshooting. I recommend this color code:

Backboard to Station Cable Functional Assignments

Position on Cat 5	Color	Designation	Network Connection	Purpose
1	Wh/Bl	T	RR	Tip of talk circuit (more or less ground)
2	Bl/Wh	R	L2	Ring of talk circuit (more or less + Supply)
3	Wh/Or	A	L1	Switched side of contact aux closure from station* (grounded when station is OFF hook*)
4	Or/Wh	A1	G	Ground side of aux closure from station
5	Wh/Grn	LG	K	As needed – but often used for LED
6	Grn/Wh	L		As needed - but often used for LED
7	Wh/Brn	Gnd	E1	Ground (black) side of buzzer**
8	Brn/Wh	LED or buzzer supply	E2	Hot (+12) side of buzzer**

Figure 3 – Backboard to Station Cable Functional Assignments/Cat 5 Color Code

items 1 and 2 (in bold) are required, the others are optional.

* optionally this can be wired as grounded when ON-Hook for use with our Relay Latch, for example.

** These are suggested uses, you can use the green and brown pairs for other functions such as a button to operate a lamp or buzzer at another location.

Installing Cup Hook Phones

Phone Installation with Cup Style Hook switch and Network

You will need the following (see figure 1):

- Cup style hook switch with DPDT contacts ***

<http://www.modelrailroadcontrolsystems.com/cup-style-hook-switch/>



Figure 4 - Cup Style Hook Switch

- Standard or push to talk G style Handset

<http://www.modelrailroadcontrolsystems.com/push-to-talk-g5-handset-with-cord/>

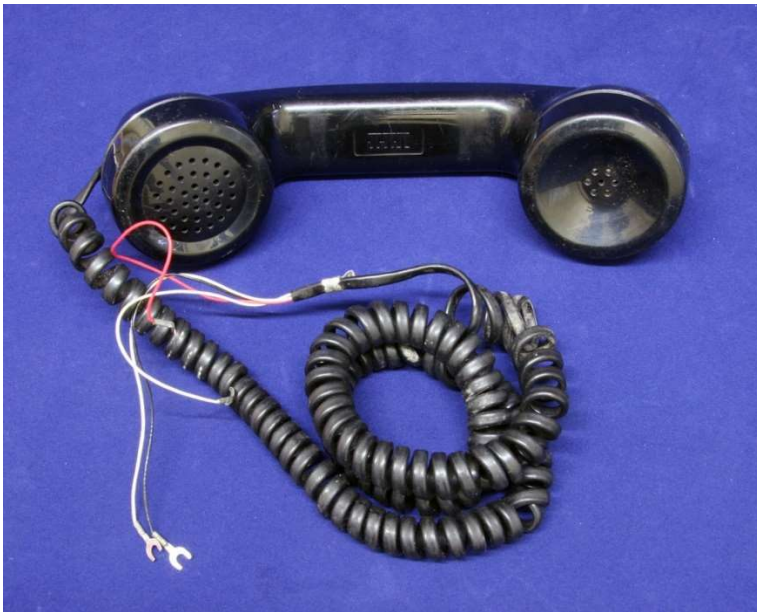


Figure 5 - G3 (Non PTT) Handset

- 425 or equivalent telephone network

<http://www.modelrailroadcontrolsystems.com/425-speech-network/>



Figure 6 –425 (classic) and ITT 181427 (modern) Speech Networks

(you can get the handset and network out of an old 500 or 2500 desk set from a garage sale)

The classic 425 has screw terminals, except for C which often (425B) has a solder tab so you need to solder a wire on it to bring C out. The modern type (it has several names depending on who made it: WECO, ITT, Stromberg-Carlson, Cortelco etc) has “Spain Clips” on each terminal which accept up to 4 wires with spade lugs and it has 2 extra terminals E1 and E2. We’ll be using these extra terminals, so it’s worth getting some spade lugs and a crimper as putting multiple wires under the screw terminals is messy and often results in unreliable connections.

Optional:

- 6 position terminal block (if you need more tie points or if you’re using old style networks)
 - Buzzer (if desired)
 - LED (if desired)
 - Push Button(s) (if desired)
- Spade lugs for telephone networks. The connection points on the modern networks are too small for the standard blue crimp connectors from the big-box stores. I like the Radio Shack (you can find them) 64-3070 or Mouser part 571-614982-LP (special order). Do not strip the wire, these are insulation displacement connectors and are designed to pierce the insulation. Use a [D-Sub Pin Crimp Tool](https://www.showmecables.com/catalog/product/view/id/63291/s/d-sub-pin-crimp-tool/) to crimp them on. I like ShowMe cables <https://www.showmecables.com/catalog/product/view/id/63291/s/d-sub-pin-crimp-tool/>

Similar tools can be found on Amazon and eBay. The crimper for the plastic insulated lugs won’t work on these lugs.

- Run a piece of Cat 5 cable from the system backboard to a convenient location under the layout near where the phone will be mounted.
- You will need to run a short piece of Cat 5 from the network through the fascia into the back of the cup hook switch.

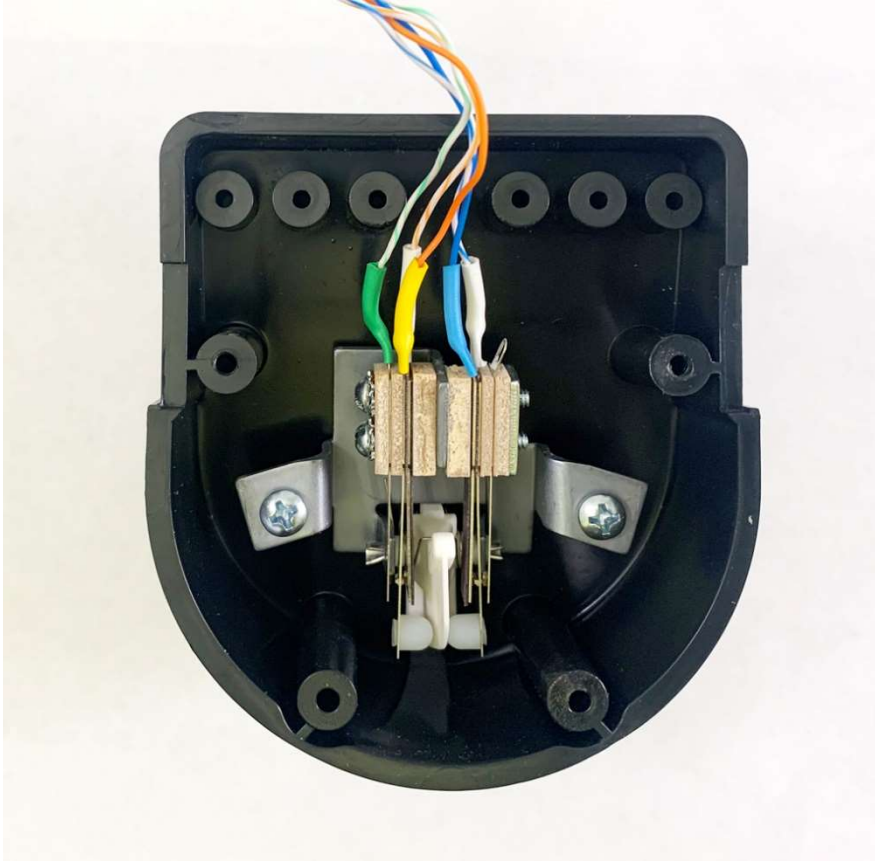
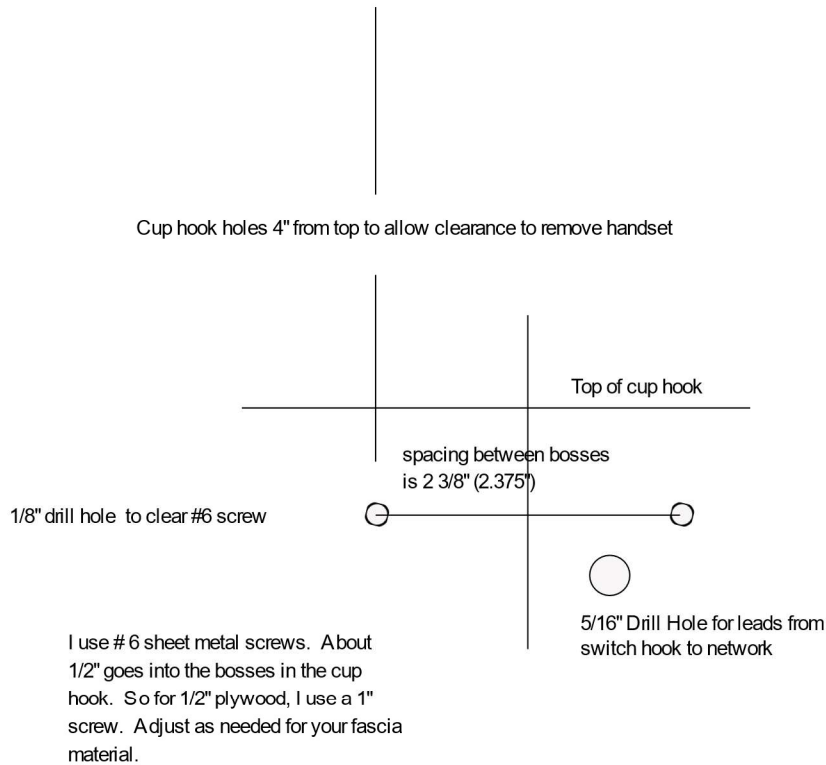


Figure 7 - Inside of Cup Hook

Contacts are shown in "Off-Hook" position



○ 5/16" Drill Hole for Handset Cord,
Off to side so cord won't interfere
with handset hanging up

Figure 8 -Cup Hook Mounting Diagram

Note that this is NOT Full Size, download the pdf template from our website if you want to tape it to your fascia and drill! Note that paper is not dimensionally stable, and some printers and copiers distort so please check measurements before you drill!

Position on Cat 5	Color	Designation	Connects to	Cup Hook	Description
1	Bl/Wh	Ring in	L2 on Network	Open when on-hook contact of contact 1	Ring of talk circuit – Connects when off hook.
2	Wh/Bl	Ring out	C on Network	Center contact of contact 1	Ring side of network. Common of first Contact
3	Wh/Or	Aux Off Hook	L1 on Network	Open when on-hook contact of contact 2	Open when ON-Hook, closed when Off-hook 2 nd contact for auxiliary circuit such as Morse Code Buzzer Controller
4	Or/Wh	Aux Common	G on Network	Center contact of contact 2	Common pin of 2 nd contact. Ground side of aux closure from station.
5	Wh/Grn	Aux ON-Hook	K	Closed when on-hook contact of contact 2	Connected when ON-Hook, used for relay latch circuit, if used. K is one side of a capacitor in the network that we don't usually use for our circuits. We're using it as a handy tie point. If you need the internal 0.47uF Mylar cap, move this connection. Also can be used for LED if desired
6	Grn/Wh	Not used	Not used		Can be used for LED if desired
7	Wh/Brn	Gnd	E1 on Network		If you want a, LED or push pushbutton on the cup hook use this pair
8	Brn/Wh	+V	E2 on Network		If you want a, LED or push pushbutton on the cup hook use this pair

Figure 9 - Cup Hook Connections – lines in BOLD are required, others are optional.

1. Connect the Wh/Bl (Tip) wire of the Cat 5 from the system back board to RR on the network

2. Connect the BI/Wh (Ring) wire of the Cat 5 from the system back board to L2
3. Identify the normally open voice contact from the cup hook switch (right as shown in the photo in figure 5). These are normally open when the phone is on hook (if you're checking with a voltmeter be sure to leave a handset in the cup while you're testing). Connect from one side of the hook switch to L2 on the network; wire the other side to C on the network. This is the talk circuit. See table above and photo of cup hook.
4. Connect the handset to the network:
 - o One of the white wires and the red wire to R on network
 - o Black Wire to B on network
 - o The other white wire to GN on Network

Network Connections

Network Terminal	Cup Hook Switch Cable	CAT5 to Back Board	Description
L2	BI/Wh	BL/Wh	Ring Side of talk pair (tie point only – no internal connection)
L1	Wh/Or	Wh/Or	“A” (tie point only – no internal connection)
C	Wh/BI		Ring side of the electrical part of the network
RR		Wh/BI	Tip side of network
G	Or/Wh	Or/Wh	Common side of A, usually ground (tie point only – no internal connection)
A			One side of internal non-polarized capacitor
K	Wh/Grn		Other side of internal non-polarized capacitor
E1	Wh/Brn	Wh/Brn	Ground side of Diode, buzzer or Push Button (tie point only – no internal connection)
E2	Brn/Wh	Brn/Wh	+ side of Diode, buzzer or Push Button (tie point only – no internal connection)
Handset Connections			
R	Handset white Handset Red		common
GN	Other Handset White		receiver
B	Black Wire		transmitter

Figure 10 - Network Connection Table

5. **Optional:** auxiliary contact. Identify the normally closed (inner) contact of the second contact set (left as shown in the photo in figure 5) from the cup hook switch. These are normally closed (making contact) when the phone is off hook (if you're checking with a voltmeter be sure to leave a phone in the cup while you're testing). Connect one to the Wh/Or wire from the Cat 5 and the other to Or/Wh. If you will be using the connected-when-on-hook side, connect the White/Green wire to the outer contact of aux contact. See table above and photo of cup hook.
6. **Optional:** Connect the Lamp (LED) pair (Wh/Grn, Grn/Wh) of the cable to the system backboard to either E1/E2 on the network or two terminals of an extra terminal strip. You'll connect the LED leads here if you want it on the fascia by the phone, alternately you can run it up to a structure of some sort on the layout, but this is still a good tie point. Be sure to select an appropriate limiting (ballast) resistor for the LED. I suggest around 1K ohms for 12 VDC ($12-1.5 = 10.5V/1000 \text{ ohms} = 10.5mA$). This is a safe value as most LEDs will give about the same brightness from 10 – 30 mA and not burn up. If you're using something special, check the data sheet for recommended current and any special limiting resistor considerations (I like the big 10mm self-flashing LEDs).
7. **Optional:** Connect the Buzzer pair (Wh/Brn/ Brn/Wh) to the E1/E2 if not already used or a pair on the terminal strip. Wh/Brn to E1 to the black lead and Brn/White to E2 to the (+) Red side of the buzzer. Double-stick or screw (# 2 sheet metal screw) the buzzer to the back of the fascia or mount it up in the cup hook. Note that the loudness of the buzzer is affected by how well the mounting surface works as a sounding board, so experiment with adhesives/screws and mounting material.

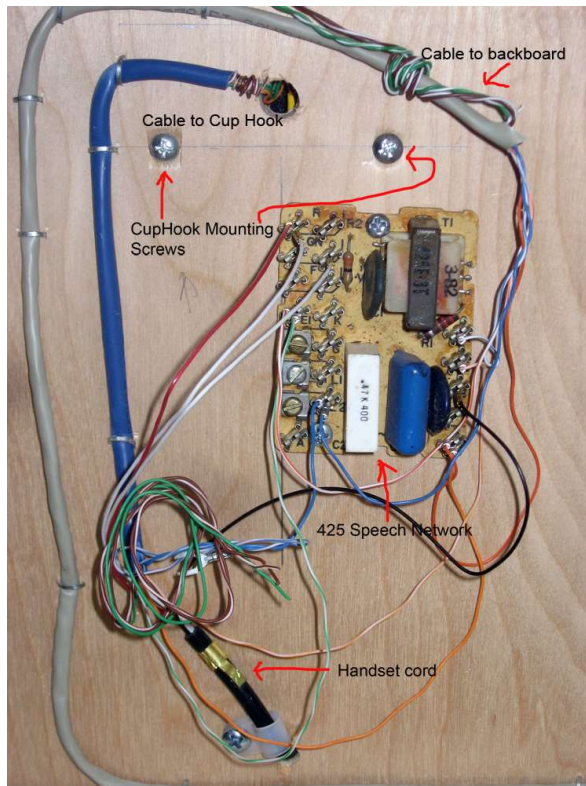


Figure 11 - Assembled Phone from Back of Fascia

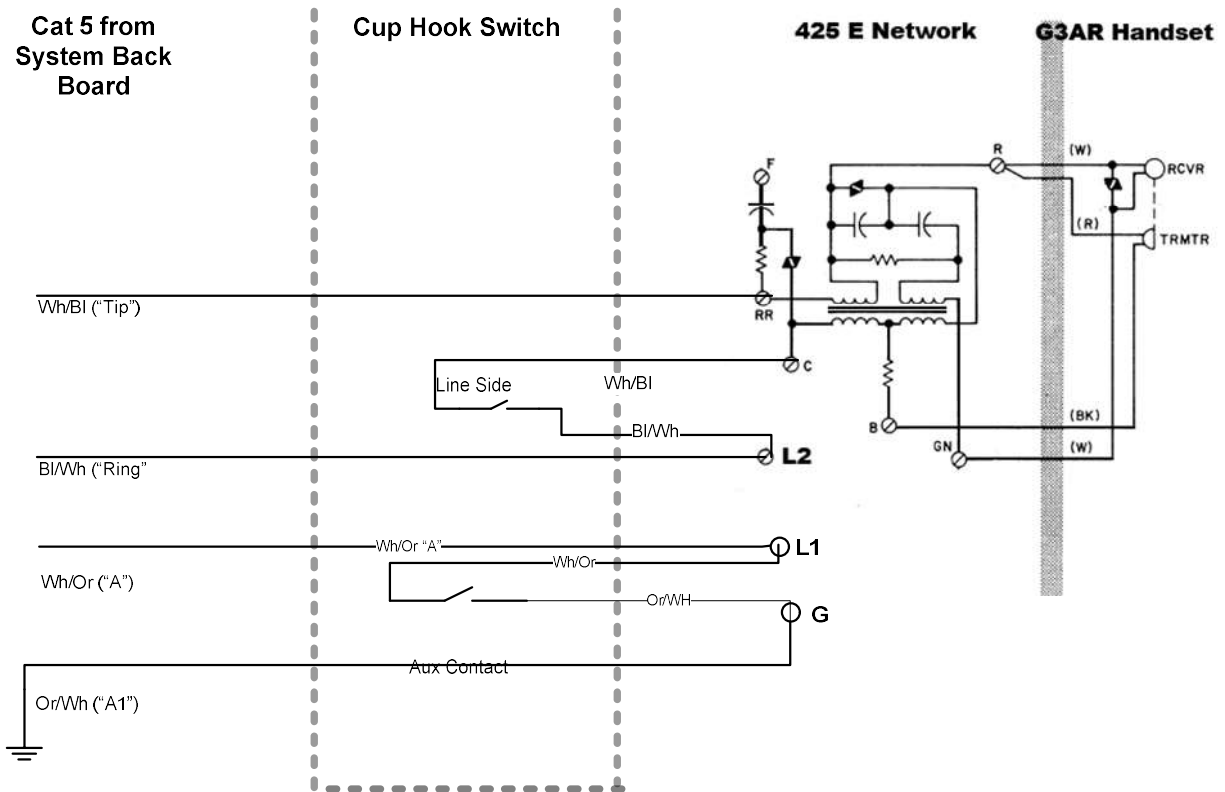


Figure 12 - Cup Hook Switch Phone Schematic

The 3rd (Green) and 4th (Brown) pairs can be used for buzzers, LEDs or push buttons as needed. See examples below.

Connections with MRCS' Morse Code Buzzer Controller (MCBC)

<https://www.modelrailroadcontrolsystems.com/morse-code-buzzer-controller/>

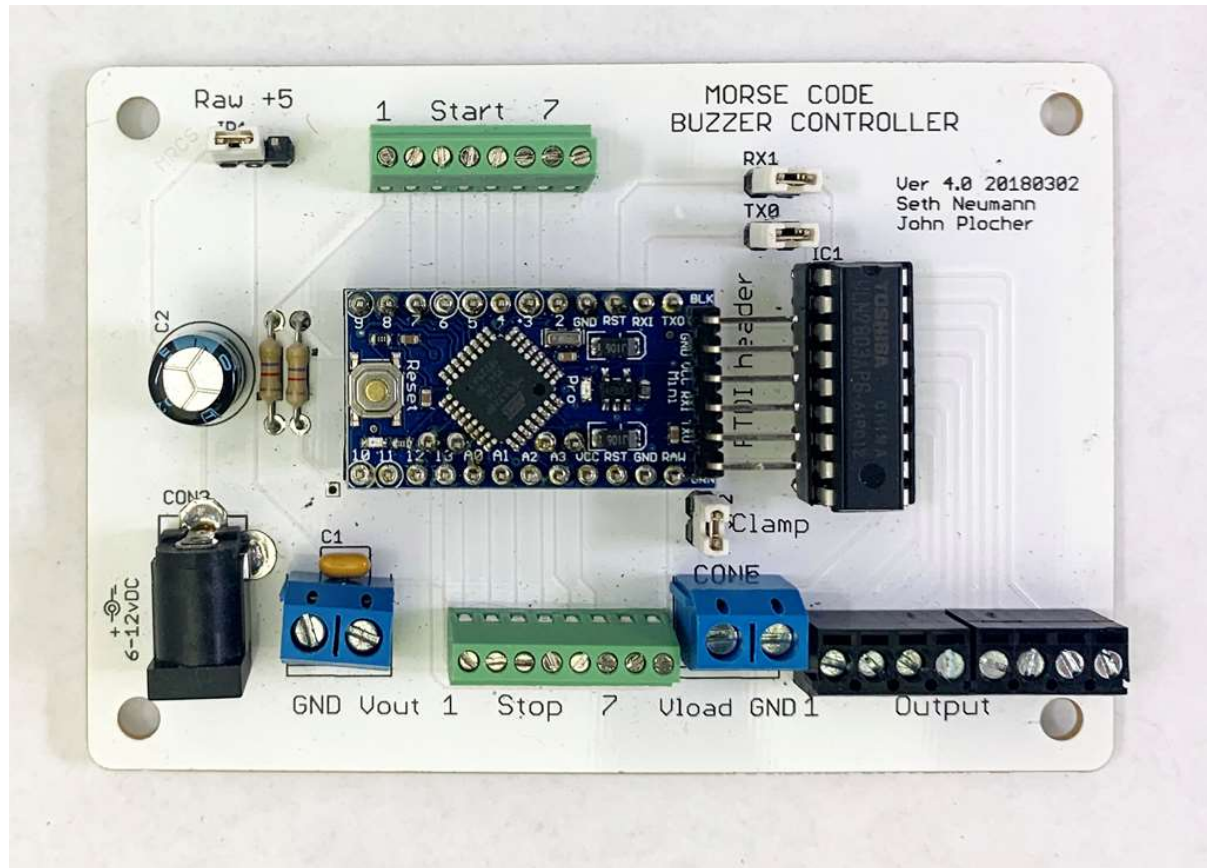


Figure 13 - Morse Code Buzzer Controller

On many operations-oriented model railroads, particularly those which use time-table and train-order (TT&TO) or tower-based dispatching systems, there is a need to provide telephone communications between the dispatcher and the agent/operators. However, even on large model railroads with multiple agent/operators, the physical distances between the operator positions are often insufficient to allow the operators to reliably determine that “hey that’s **my** phone ringing.”

The Morse Code Buzzer Controller board controls up to seven stations, tapping out each ringing station's Telegraph call sign in Railroad Morse. An additional output can be designated as an “ambience” buzzer that will randomly play one of several canned messages. These could be train orders, news reports, or “inside jokes”

The board accepts push button inputs, stops when the phone goes off-hook (phone must have a suitable contact to provide an isolated ground) and can drive loads of up to 0.5 Amp at up to 48 Volts DC. All buzzer/sounder devices must use the same supply. Sounders must have a coil resistance of greater than 40 ohms if using a 12V supply.

The MCBC requires a 6-9 VDC power supply rated at $\geq 0.5A$. (not included)

Suggested Station Connections for MCBC:

Position on Cat 5	Color	Designation	MCBC Connection	Purpose
1	Wh/Bl	T	None	Tip of talk circuit on EBF31A or other battery feed
2	Bl/Wh	R	None	Ring of talk circuit on EBF31A or other battery feed
3	Wh/Or	A	STOP terminal of station [1-7] on MCBC	Switched side of contact aux closure from second cup hook contact (grounded when station is OFF hook*)
4	Or/Wh	A1**	MCBC Ground	Ground side of aux closure from second cup hook contact
5	Wh/Grn	LG	None	
6	Grn/Wh	L	None	
7	Wh/Brn	Ground**	OUTPUT terminal [1-7] on MCBC	Ground (black) side of buzzer**
8	Brn/Wh	LED or buzzer supply	+ side of buzzer supply	Hot (+12) side of buzzer**

Figure 14 - Morse Code Buzzer Controller Connections

** you may want to setup distribution terminal blocks for buzzer power and A1 ground. This board below takes power and ground in on the center terminal and provides 12 outputs per input.

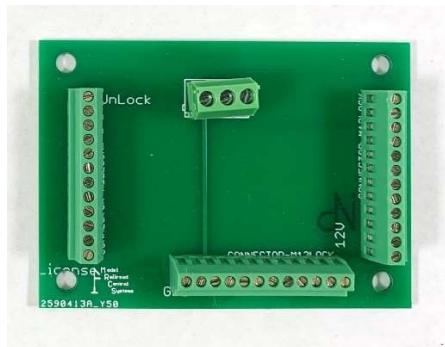


Figure 15 – MRCS' Power and Ground Distribution Board

If you want a visual indication as well as audible buzzing, place an LED in parallel with the buzzer. Our standard buzzer draws about 30 mA which is about the limit a modern LED can handle, so it's best not put it in series with the buzzer. We recommend connecting an LED in parallel with the buzzer, selecting a suitable limiting resistor to keep current to about 10 mA but this may vary depending on the type and

color of the LED. Good starting values are 1K ohm at 12 V and 2.2K at 24V. Blue and White LEDs will be a lot brighter, so you may use higher resistance values.



Figure 16 – Vellman SvM12N buzzer (12VDC)

<http://www.modelrailroadcontrolsystems.com/dc-buzzer/>

We recommend the Vellman SvM12N buzzer, Red to +12V, Black to ground, draws ~30mA. Available from your favorite electronic supplier.

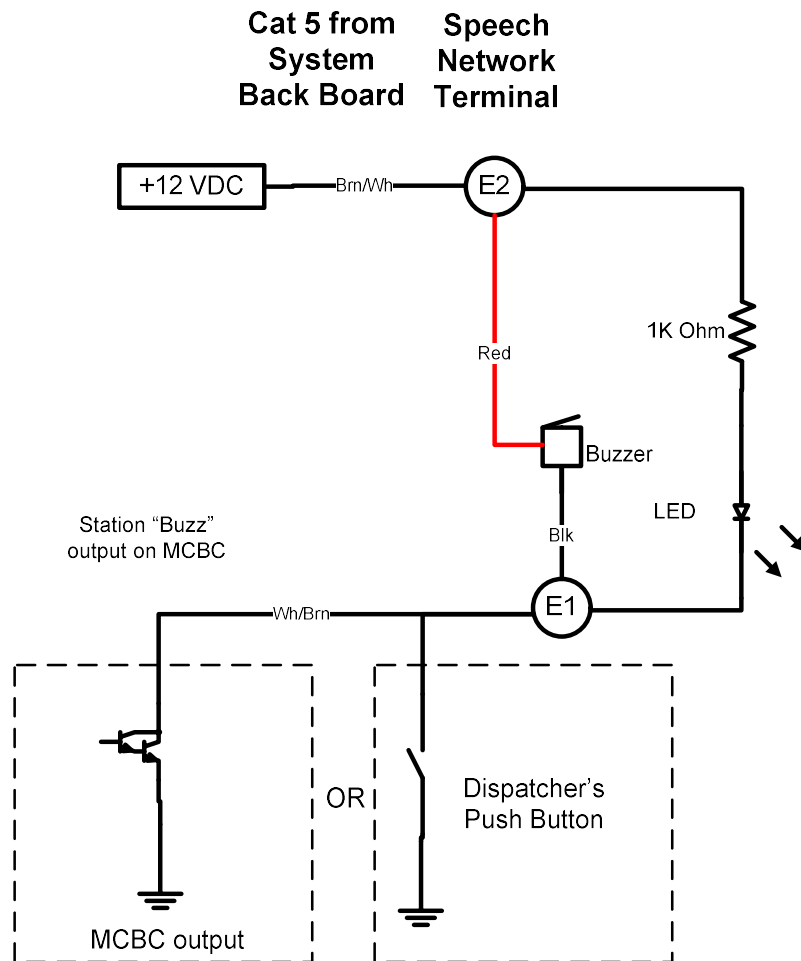


Figure 17 - LED - Buzzer Parallel Combination

The STOP and OUTPUT connections are at the bottom of the board. Buzzer supply ground and the A1 grounds should be connected to one of the “ground” connections.

The buzzer supply should be connected to Vload to enable the internal snubber diodes on the ULN2803 chip. See the Morse Code Buzzer Controller manual for more information. (The snubber diode protects against the high voltage spike the sounder makes as it releases)

Relay Latch Connections

Buzzers, either directly controlled by push buttons or driven by the MCBC, are useful at manned stations but just add to the noise during an operating session when buzzing at an unmanned station. Some operators at manned stations may also find constant buzzing annoying if they’re busy with other tasks. A solution is to buzz once and then light an LED to alert a passing crew or to remind yard operator to pick up the phone and contact the Dispatcher. The LED is turned off automatically when the phone is taken off-hook.

You’ll need a relay with two or more sets of contacts, DPDT or 4PDT, and a pair of 1N4001 (or better) diodes. For this example, we’ll use our OMRON Relay Breakout but any handy DPDT relay will do. We make these in 5, 12 and 24 volts, the relay is a G5V-2-H series which is available from many suppliers.

<http://www.modelrailroadcontrolsystems.com/omron-relay-breakout/>

The OMRON Relay Breakout is a DPDT relay with a snubber diode and 0.100 8 position terminal block. (The snubber protects against the high voltage spike the relay makes as it releases)

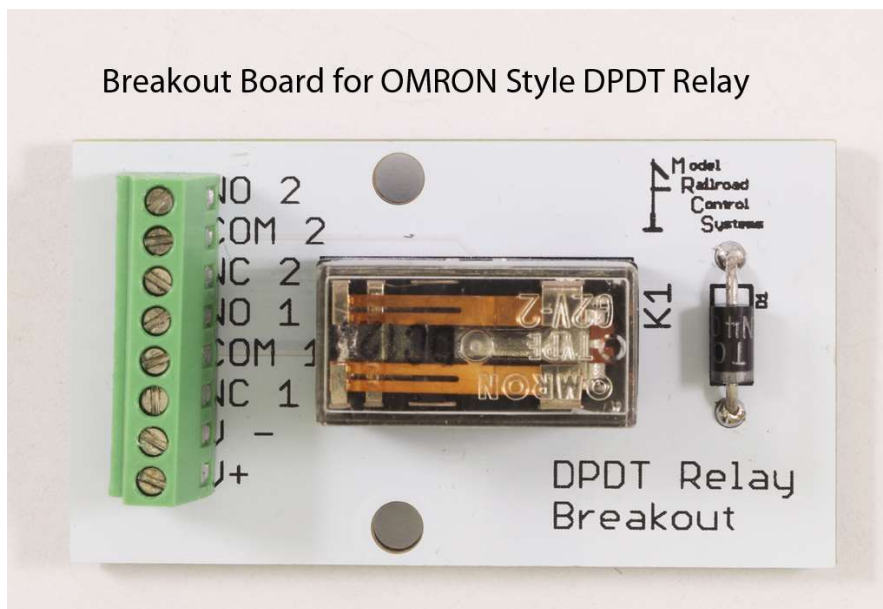


Figure 18 - Omron Relay Breakout

Suggested Station Connections for Relay Latch:

Position on Cat 5	Color	Designation	MCBC Connection	Purpose
1	Wh/Bl	T	None	Tip of talk circuit on EBF31A or other battery feed
2	Bl/Wh	R	None	Ring of talk circuit on EBF31A or other battery feed
3	Wh/Or	A	none	Switched side of contact aux closure from second cup hook contact (grounded when station is ON hook*) See hook switch wiring figure 8, use Wh/Grn wire.
4	Or/Wh	A1**	Ground	Ground side of aux closure from second cup hook contact
5	Wh/Grn	LG	None	
6	Grn/Wh	L	None	
7	Wh/Brn	Buzz Start**	Push button at DS to operate buzzer and latch	Ground (black) side of buzzer**
8	Brn/Wh	LED or buzzer supply	+ side of buzzer supply	Hot (+12) side of buzzer**

Figure 19 – Relay Latch Connections

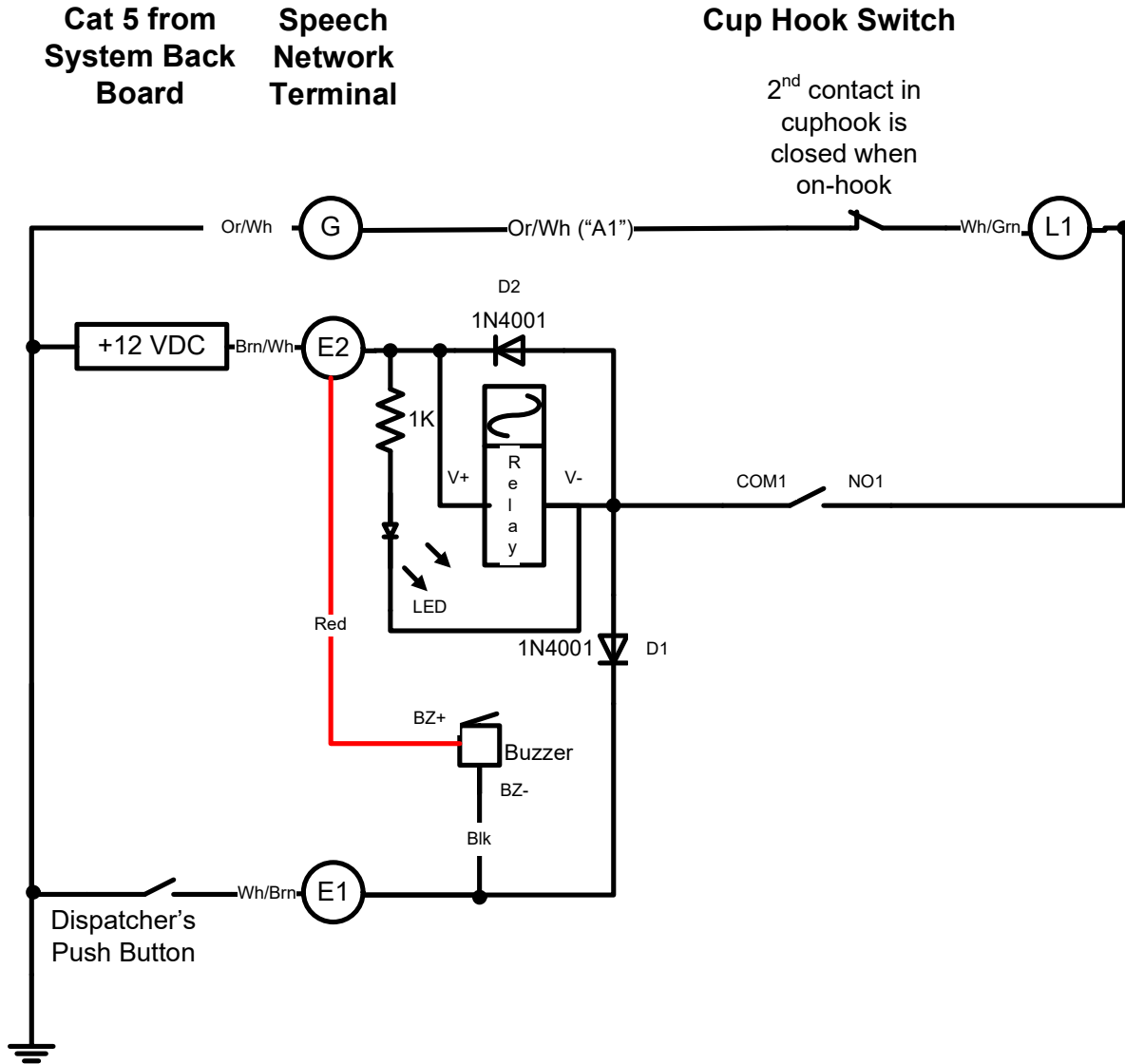


Figure 20 - Latch Schematic

Latch Theory of Operation:

- In the idle state the relay is off, and the LED is Dark
- When the Dispatcher wants to call the station, he presses a push button at his desk.
 - This applies a ground at E1 and the black (- end of the buzzer) and the buzzer (red end is connected to +12 at E2) starts to buzz.
 - The ground is also applied to the V- terminal of the relay through the diode (1N4001).
- The relay operates, closing contacts 1 and 2
 - The relay now has a holding path through contact 1 (COM1/NO1) through L1 and the normally closed (when on hook) cup hook contact 2 to Ground.
 - The LED is in parallel with the relay and lights as long as the relay is operated
- When the Dispatcher releases the push button:
 - The Buzzer will stop buzzing

- the relay will stay operated under control of the normally closed (when on hook) hook switch contact.
- Station Goes Off-Hook
 - The holding circuit for the relay is in series with normally closed cup hook contact 2, which is removed when the station goes off hook, causing the relay to release and the LED to go dark
- Snubbing (reverse voltage spike protection) is provided by D2.
- This circuit has the useful property that the DS can “re-ring” a station that has already answered, for example the DS called the Yardmaster about the departure of an upcoming train. The YM goes off to check and gets distracted but has left his phone off-hook. The DS can press his push button and the buzzer will buzz and the LED will light.

Many other latch and LED circuits are possible. Contact us if you have a different requirement.

Off Hook Indication

Many layouts report problems with operators picking up aisle phones and speaking before listening to check if a conversation is in progress. Even with push-to-talk handsets (and especially with standard handsets) the tendency is to start talking if no one is heard speaking. However, there are silences during conversations particularly when reading and repeating train orders and clearances. You can use an LED to indicate if any station on the circuit is off hook (not counting a Dispatcher station which may be listening all the time). The “in use” LED alerts operators that the circuit is in use.



Figure 21 - LED installed on Cup Hook (courtesy of Tommy Holt)

In any case, you need to drill a suitable hole for your LED in the cup hook, Tommy Holt mounted them on top as above. Install a limiting resistor to keep current to about 10 mA but this will vary depending on the type and color of the LED. Good starting values are 1K ohm at 12 V and 2.2K at 24V. Blue and White LEDs will be a lot brighter, so you may want higher resistance values.

There are two ways to get a circuit busy indication:

If the dispatcher's set does not draw loop current from the same battery feed as the aisle phone (for example, using our ATSN), you can use a contact on the relay of our Electronic Battery Feed 31A (EBF31A) to control LEDs on each station.

- 1) Using our EBF31A or a 31A KTU
 - a. I recommend using the Wh/Grn, Grn/Wh pair for the line-in-use lamp. Connect the positive side of the LED (Anode, long lead) to 12V if you've already supplied it to the phone or use the Green/White wire. Connect the negative side (Cathode, short lead, flag) to the White/Green wire.
 - b. Back at the central backboard, connect the negative sides from all of the phones to the one of the normally open contacts on the EBF31A (or a classic 31A KTU if you have one) and the common contact on the EBF31A to ground.

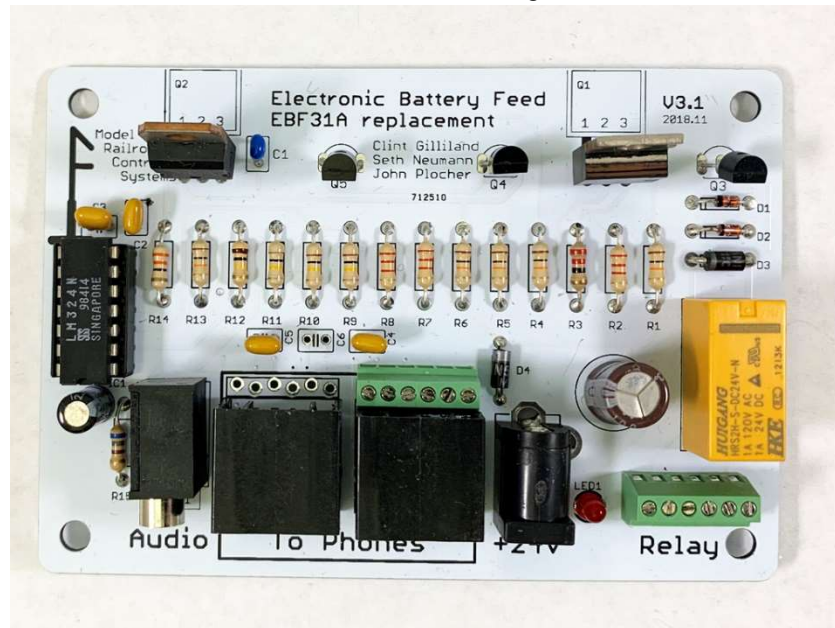


Figure 22 - EBF31A Version 3.1- Note relay in lower right

- 2) If the dispatcher's set shares the same battery feed, you can't use the battery feed contact (as it will always be on during a session) but you can build a diode matrix from the "A" leads of the phones that you want to indicate:
 - a. Wire the A leads on the Wh/Or wires and A1s on Ow/Wh per figures 3 and 8.
 - b. At the central backboard, connect the – end (Cathode) of a diode (1N4001 or better) to the A Lead of each station (check with us if you want to do this in parallel with an MCBC). Connect all of the +ends (Anodes) together and then to the LG (Wh/Grn) leads of all the stations.
 - c. As above, you can use 12V if you've already sent it to the phone for buzzer or latch relays, if not apply +12 (or whatever voltage you've chosen) to the "L" Grn/Wh wire.

Other

*** there are multiple terms for contacts, this table is a Rosetta Stone:

General Electronic	Single Poll, Single Throw Normally Open (SPST-NO)	Single Poll, Single Throw Normally Closed (SPST-NC)	Single Poll, Double Throw
Telephone, Industrial Control	Form A	Form B	Form C
Railroad Signaling	Front Contact	Back Contact	Front and Back Contacts, transfer contacts

Figure 23 - Contact Terminology