E & M Signaling

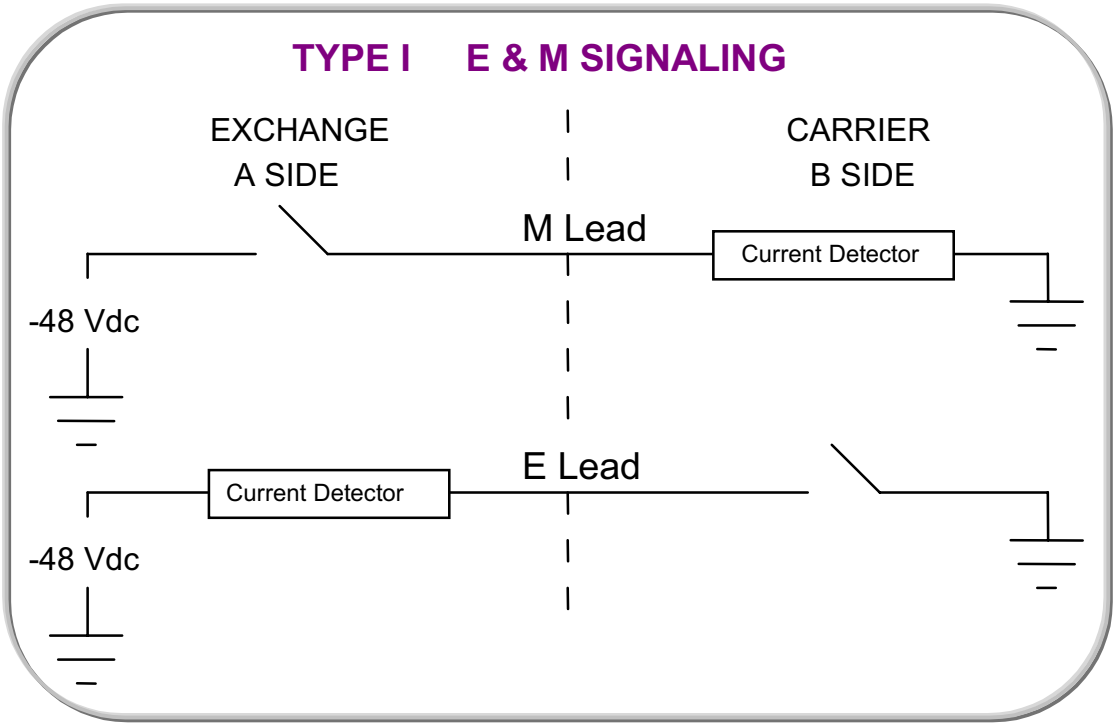
Introduction

Transmission and signaling are service components of telephone calls. Transmission is the transport of voice signals between one telephone exchange and another. Signaling allows management of the calls. Signaling involves the functions of (a) request for service, (b) request for dialing, (c) ringing, (d) answer supervision, (e) call monitoring, and finally (f) call termination. During early telephony years, when copper wires were used for trunk lines between telephone exchanges, also called central offices, direct currents in the line were used for signaling. In one direction, "loop open" and "loop closed" were used. In the reverse direction, "normal polarity" and "reverse polarity" battery currents were used.

With the advent of analog carriers, tones replaced dc currents for signaling. The E&M signaling method was designed as a conversion standard between dc currents and tones, which for North American analog carriers was 2600 Hz. Later, for digital carriers, dedicated bits provide the same signaling function.

Type I E&M Signaling

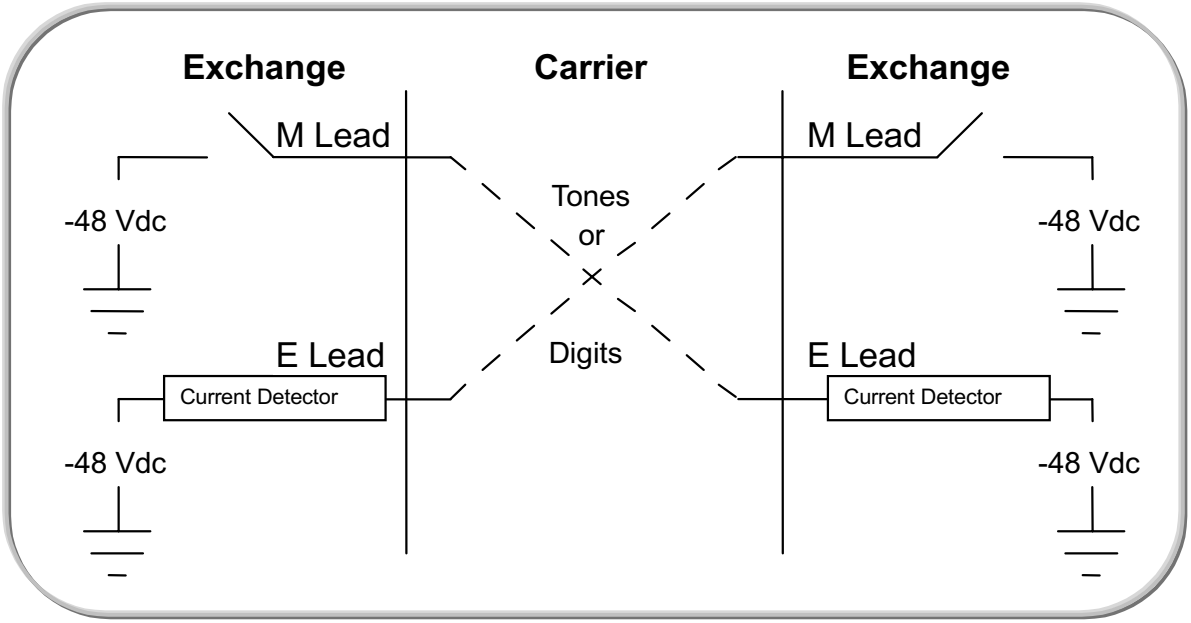
The original E&M circuit is shown below.



In a four wire circuit, the leads T and R (tip and ring) designate the pair of wires for transmitting voice signals from the exchange to the carrier. The leads T1 and R1 designate the receiving pair of wires. When two more leads were added for signaling, engineers did not want to repeat the choice of T and R for transmit and receive. Instead, they chose E and M derived from the second syllables within the words "receive" and "transmit". Subsequently, the mnemonics E for "ear" and M for "mouth" became popular.

For simplicity, the voltage sources of -48 V for both E lead and M lead are on the exchange side. On the carrier side, detection of current in the M lead, which is controlled by a switch on the exchange side, results in sending of the 2600 Hz tone for analog carriers and setting of the A bit for digital carriers. On the exchange side, detection of current in the E lead, which results from reception of the 2600 Hz tone or the A bit, asserts that the distant exchange has sent current in the far end M lead.

In an end-to-end circuit, therefore, sending a current in the M lead at the near end results in detection of current in the E lead at the far end. In this way, the two exchanges can "signal" each other, as shown below.



Because E&M circuits are also used in a tandem connection of two carriers, to avoid confusion in nomenclature, the exchange side and carrier side are also called the A side and B side. For carrier systems, B side is the normal side, while the A side is used in a tandem connection.

Technical Issues of Type I E&M Signaling

Following initial installation of the E&M circuits, several technical issues surfaced. The solutions to each of these technical issues resulted in variations of the original E&M circuit. These technical issues are as follows.

(1) Because the return current is through the ground connection, when large numbers of E&M circuits are in use, significant ground noise is generated, which affects voice signal quality..

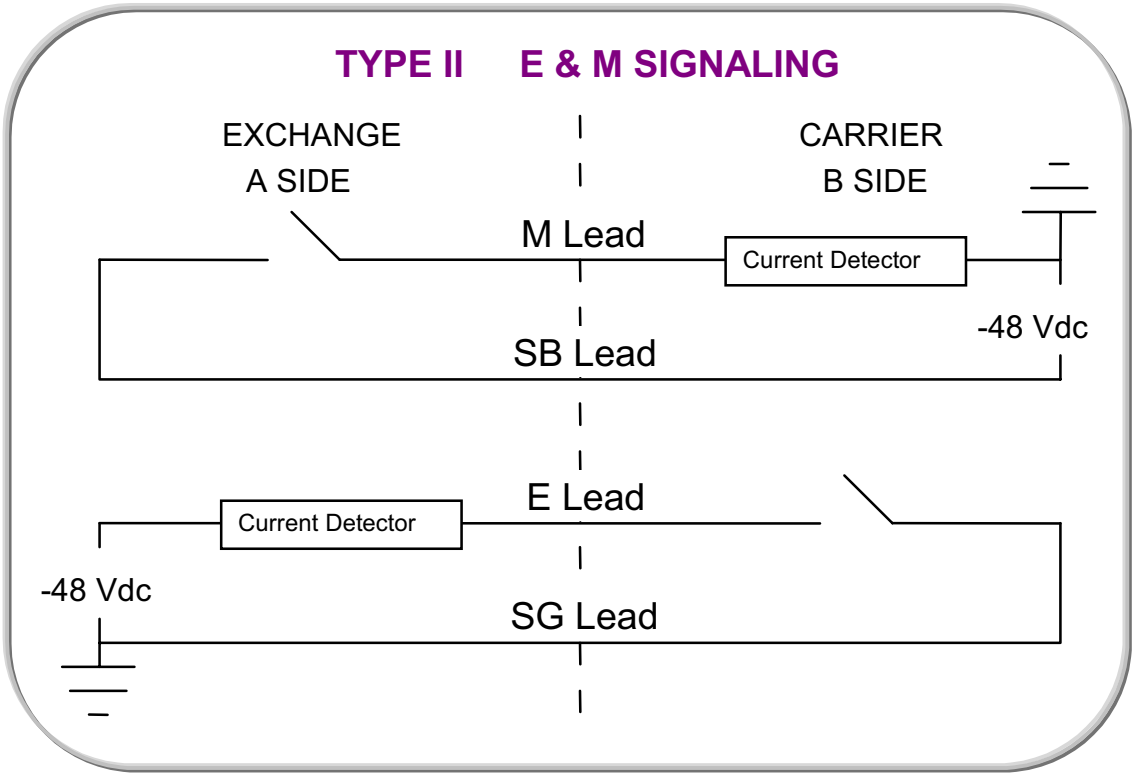
(2) Because the original design is only for exchange to carrier connection, the two sides, A and B, are not symmetric. This causes complications for carrier to carrier connection, as when two carriers are connected in tandem. In such cases, with the original E&M design, one of the carrier interfaces must emulate an exchange.

(3) When the E&M leads are very long, resulting in significant inductance and capacitance , delays in the signaling operation for certain designs can occur.

To address one or more of these issues, derivatives of the original E&M circuit were introduced. These are designated types II to V, with the original E&M designated as Type I.

Type II E&M

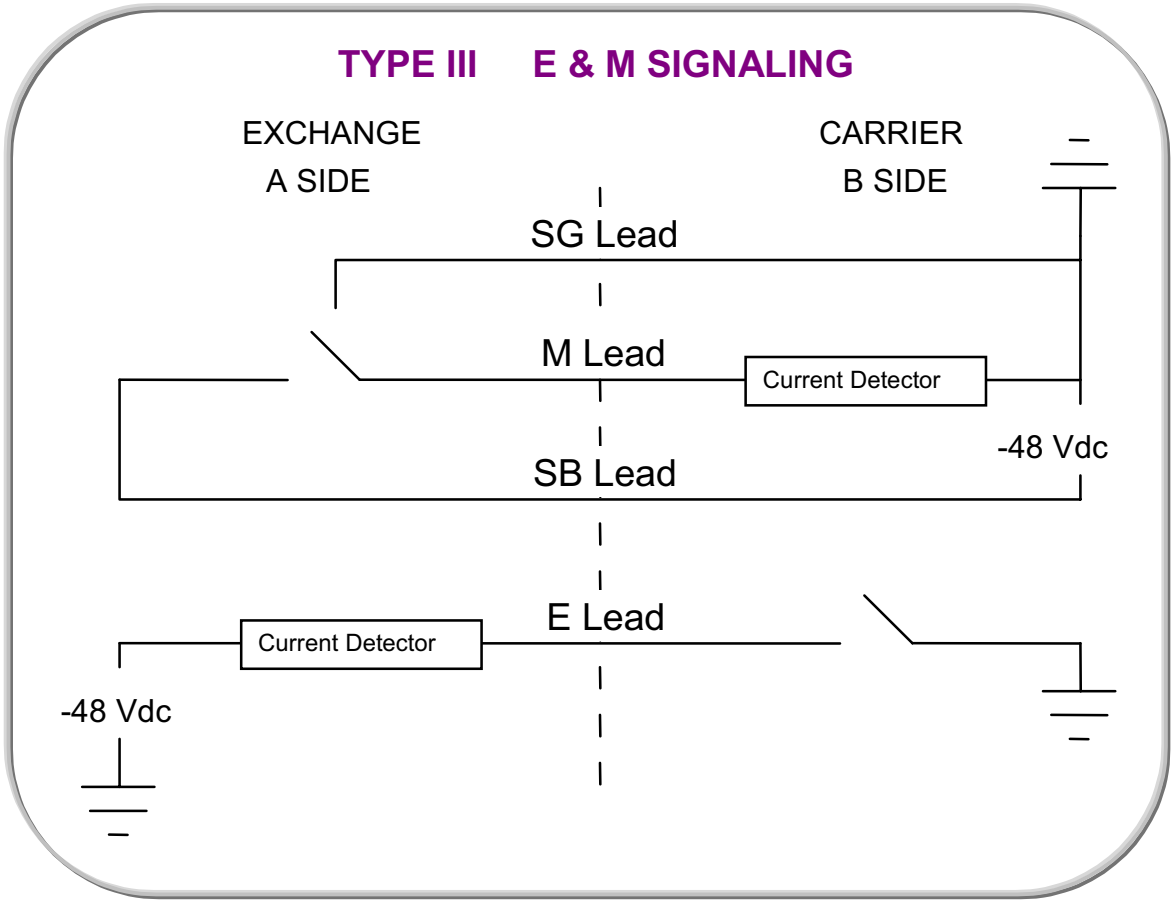
In the first attempt to reduce ground noise, Type II E&M was designed. Starting from the original circuit, the leads connected to the other side of the switches were made to run back parallel to the E and M leads. In this way, ground current is eliminated at the cost of two more wires per circuit.



This design requires the B side, the carrier side, to supply battery. The lead designation SB suggest "signal to battery", while SG suggest "signal to ground".

Type III E&M

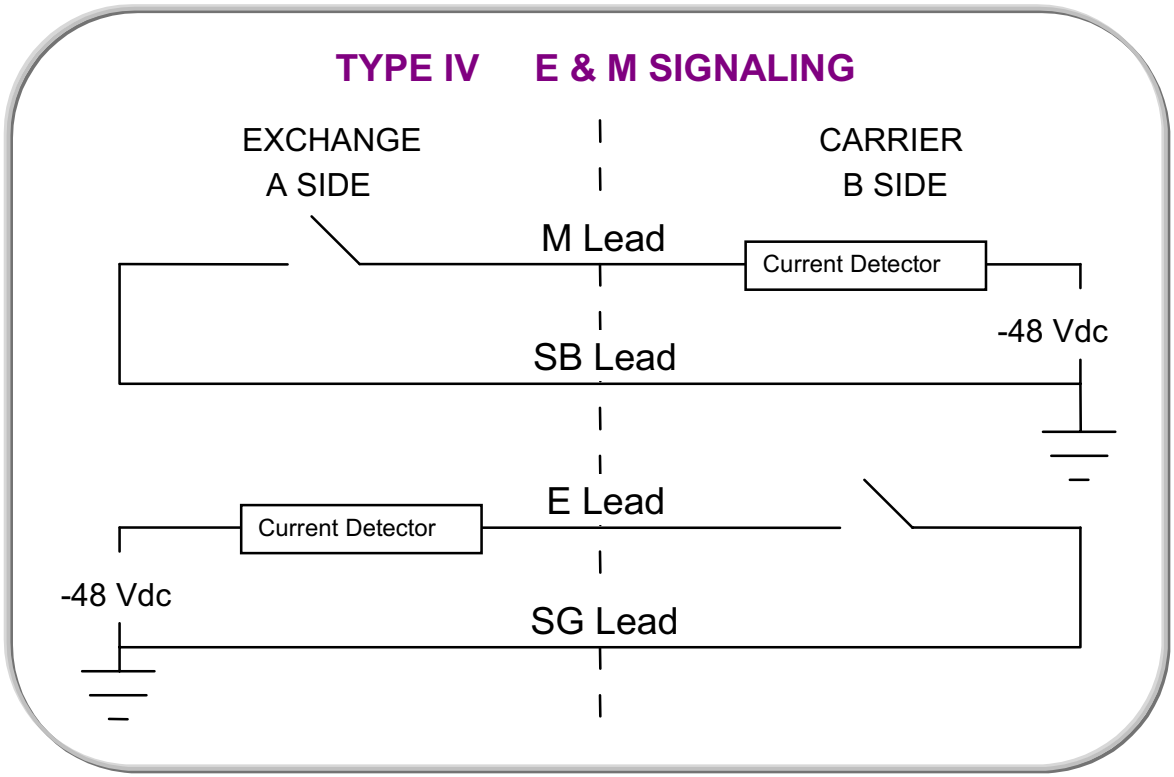
In another variation of E&M, Type III, the SG lead used above is moved to serve as discharge for the M lead. This reduces delay caused by the combination of (a) low current electronic detectors, and (b) long runs of the E and M leads. Because ground currents on the E return would cause noise, Type III is rare.



Type IV E&M

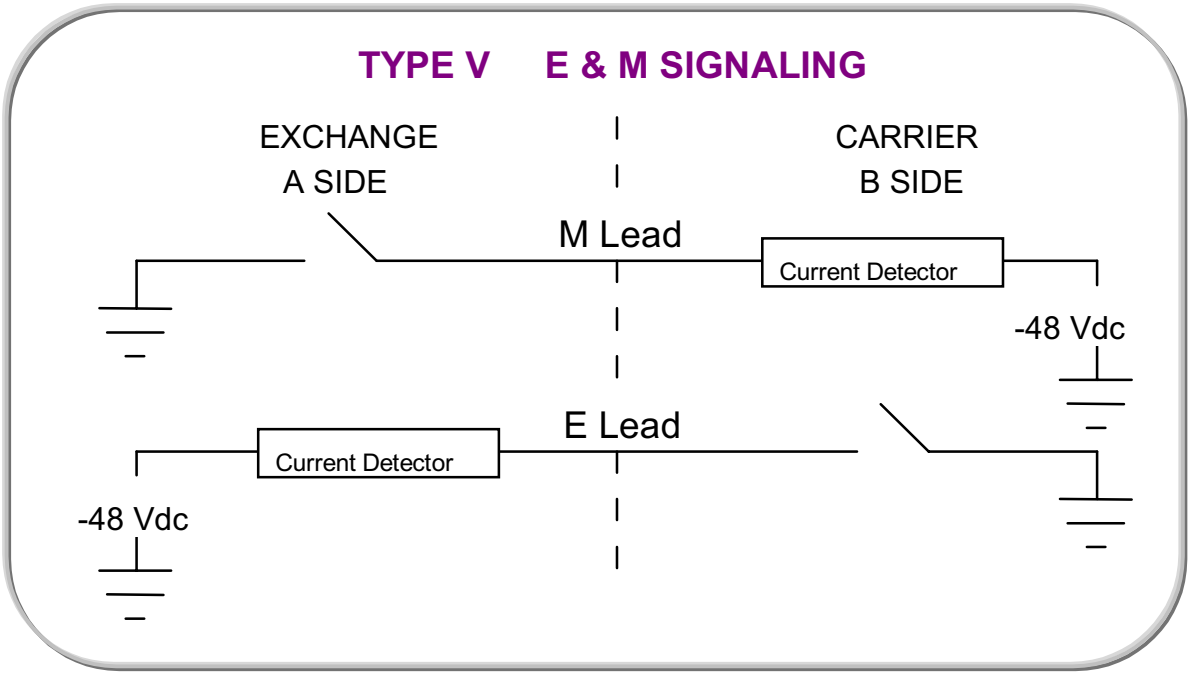
This E&M circuit provides symmetry. Starting from the Type II circuit, on the B side, the battery and ground are interchanged so that the M circuit is now the mirror image of the E circuit, resulting in a Type IV. In this way, tandem connection of carriers can use the same E&M circuit. Such connections occur often in trunks consisting of a wire line carrier in tandem with a wireless carrier. A "cross-over" cable interconnects the two carriers.

Although still labeled SB, this lead now connects to ground, just like the SG lead.



Type V E&M

Finally, for circuits where ground noise is not an issue, but symmetry is desired, the SB and SG leads can be eliminated from the above circuit, resulting in Type V E&M.



In this circuit, as in Type IV, the A and B sides are symmetrical, allowing for tandem operation. At sites where carriers meet, the number of such connections are usually small enough not to result in significant ground noise.

Conclusion

With many types of E&M circuits in use, types I to V with A and B sides for each, network designers must insure that at each juncture, between exchange and carrier, and between carrier and carrier, all circuits have matching types and complementary sides.

For Loop AM-3440, the E&M plug-in card allows the user to choose the type and side of E&M circuit during the installation process. This permits some trial and error. For Loop V-4200, because of space limitations, one of the ten optional circuits of the E&M card must be specified on the initial order. Thus network designers should exercise care in ordering the correct E&M plug-in. On the Loop V-4200 E&M plug-in card, the circuit type and side can be changed in the field by exchanging a daughter card on the plug-in.