Recommended Vital Circuit Design Guidelines Using Electric Switch Machines
Revised 2025 (7 Pages)

A. Purpose

This Manual Part recommends vital circuit design guidelines for electric switch machines.

B. General

1. The recommended vital circuit design guidelines presented in this Manual Part apply to dual and non-dual control electric switch machines. A non-dual control switch machine shall be considered as a switch that is NOT equipped with a power selection lever and hand throw arm. A dual control switch machine shall be considered a power switch machine equipped with a hand throw - power selection lever and a hand throw arm. The provision for hand crank is provided on both types of machines.

2. These guidelines apply to both low voltage (24 volts) and high voltage (110 volts), either ac or dc switch machines.

3. The vital circuit design guidelines provided in this Manual Part shall also apply to equivalent software applications.

4. The vital circuit design guidelines provided in this Manual Part represent one method of design for electric switch machine circuits. Some aspects of the design may vary depending on the design practices of the individual railroad.

C. Circuit Design

1. The circuits shown in this Manual Part consist of four primary types of circuits:

   a. Switch position request;

   b. Motor control;

   c. Overload; and

   d. Switch correspondence.

2. The circuit design diagrams in this Manual Part are drawn based on the switch requested and in correspondence in the NORMAL position.

3. The circuit design shown in Figure 1665-1 is based on 3-wire motor control circuits utilizing rectified ac.

4. The circuits in this Manual Part show the hand crank contact in the motor control circuit, which will open the motor control circuit whenever the crank is operated.

   On dual control switch machines, the selector lever and hand throw contacts are in series with the crank check contact. If either of these contacts are opened, the switch cannot be operated electrically. Contacts of the selector lever and the hand throw lever are also placed in the correspondence circuit to open the correspondence circuit when either of these levers are operated. If operation of the switch machine by hand-throw results in full lock rod protection, contacts of the selector lever may be omitted from the correspondence circuit; however, operating rules and related circuits must be coordinated to ensure safe operation.

D. Typical Circuit Operation

1. Switch position Request - Refer to Figure 1665-1.

   The coils of the relays NWZR and RWZR are not shown; however, these relays are usually energized by an output from a code system or Local Control Panel. The NWZR will energize with a "NORMAL" switch request and the RWZR will energize with a "REVERSE" switch request.

   The circuits in Figure 1665-1 are drawn with the switch requested in the NORMAL position. This Manual Part discusses the vital circuits and events that are checked based on requesting the switch to the NORMAL position.

   When the NWZR is energized, it energizes the normal switch relay (NWR), through the front contacts of the Lock Relay (LR) , and the back contacts of the RWZR. The purpose of the LR front contacts is to prevent energizing the Normal Switch Relay (NWR) or Reverse Switch Relay (RWR) while electric locking is in effect.

   In order to protect against an LR dropping while the switch is in motion and stopping the switch on center, an optional Lock Stick Relay (LSR) circuit may be used, see Figure 1665-2. If the optional LSR relay is used, then a back contact of that relay shall be inserted in the home network wherever the lock relay contact is used. When detector locking is desired for a switch in motion, the OTR is used in the LSR circuit as shown in Figure 1665-2.

   The prevention of a preconditioning for the movement of the switch points to another position when a route is lined or in use over it is normally accomplished in the NWZR and RWZR circuits.

   The pick path of the NWR checks the back contact of the RWZR to ensure it is not in a position that will request the switch reverse.

2. Motor control circuit. Refer to Figure 1665-1.

The motor control circuit consists of 3 wires - WC, WN, and WR where WC is the common wire. The WN and WR wires and the circuits connected to them are used to drive the motor to position the switch machine either NORMAL or REVERSE.

The circuits are designed to ensure there is no energy applied to the motor when the switch machine is fully in the requested position, either NORMAL or REVERSE. This is accomplished by the switch machine design itself where the contacts of the switch machine are driven by cams operated by the throw mechanism of the machine. As the switch machine moves from NORMAL to REVERSE, and vice versa, these contacts will open and close at various stages of the switch movement.

To demonstrate what occurs when the switch machine is requested NORMAL, presume the position of the motor contacts are opposite to that shown in Figure 1665-1, and they will assume the depicted position when the switch completes its movement to the NORMAL position. The same applies to the contacts of relays NWR and RWR. Presume the contacts of NWR are down and the contacts of RWR are up. The following table shows the position of the contacts in relation to the position of the switch machine:

Table1665-1: Motor Control Contacts

Contact Number	Normal	Reverse
C1-D8	Closed	Open
C2-D7	Open	Closed
D5-D6	Open	Closed
C3-C4	Closed	Open

Therefore, with the switch machine in the REVERSE position and the switch machine requested NORMAL, after the switch machine completes its full movement to the NORMAL position, the circuits will end up exactly as they are drawn.

When the NWR is energized, the circuit applies energy to the motor winding 1-4, through contacts 2-7 (closed) checking the crank contact 11-6. The RWR is de-energized the moment the NWR is requested. Back contacts of the RWR are checked in the motor control circuit to apply the proper polarity to the motor and to engage the Overload Relay (OR). Refer to paragraph D.3.

As the switch machine reaches the end of its movement, contacts 3-4 will close engaging the motor snubbing circuit and the dynamic braking feature of the machine, slowing the switch movement, to avoid excessive "slap" or pressure on the drive mechanism.

3. Overload circuit. Refer to 1665-1.

Switch machine motor assemblies are equipped with a clutch designed to protect its gears if the switch points become obstructed. When the clutch becomes engaged, the motor will continue to operate unless its control circuit is opened. The circuits in 1665-1 show both coils of the OR. The "O" or overload coil is used to monitor the current in the motor circuit. If the current exceeds the adjustment limit (set according to the recommended slip current of the machine), the "O" coil energizes. The make before break contact of the OR is used to establish the "S" or stick coil before the "O" coil de-energizes. The OR relay contact then opens the NWR circuit.

The "S" coil remains energized through the contacts on the NWZR and RWZR request relays. The coil will reset whenever the switch is requested to the opposite position. This allows the switch to be moved back to its original position.

In lieu of an OR, it is permissible to use a time-based motor cutoff that opens the motor circuit if a switch is operated and fails to complete its movement within a predetermined time.

4. Switch Correspondence Circuit. Refer to Figure 1665-1.

Switch correspondence circuits verify that the switch points are in the position requested. The point detector rod is adjusted so that the applicable circuit controller contacts (either NORMAL or REVERSE) will close when the switch point is less than 1/4 in (6.35 mm) from full NORMAL or full REVERSE, where a latch-out device is not used, and to within 3/8 in (9.53 mm) where a latch-out device is used.

To demonstrate what occurs with the switch correspondence circuits when the switch machine is requested NORMAL, presume the position of the indication contacts are opposite to that shown in Figure 1665-1 and they will assume the depicted position when the switch machine completes its movement to the NORMAL position. This also applies to the contacts of relays NWZR and RWZR. Presume the contacts of NWZR are down and the contacts of RWZR are up. The following table shows the position of the switch machine indication contacts in relation to the position of the switch:

Table 1665-2: Switch Machine Indication Contacts

Contact Number	Normal	Reverse
D1-D2	Open	Closed
D3-D4	Open	Closed
C5-C6	Closed	Open
C7-C8	Closed	Open

Therefore, with the switch in the REVERSE position and the switch requested NORMAL, after the switch completes its full movement to the NORMAL position the circuits will end up exactly as they are drawn.

Referring again to Figure 1665-1, the Reverse Switch Correspondence Relay (RWCR) de-energizes when the NWZR energizes. At this point the switch machine is "out of correspondence". In addition, the REVERSE switch machine contacts D1-D2 and D3-D4 will open as soon as the switch machine begins to move from the REVERSE position. The NORMAL switch machine indication contacts C7-C8 and C5-C6 will close when the switch points are detected to be less than 1/4 in or 3/8 in from normal as applicable. Providing the NWZR is still energized, the Normal Switch Correspondence Relay (NWCR) energizes when the NORMAL contacts close.

The switch machine circuit controller contacts are wired to ensure the correspondence relay coils are shunted while the machine is in transit.

E. Miscellaneous

1. Heaters (usually 25 watts) are sometimes located in the switch machine to reduce the amount of frost buildup and condensation forming on the motor and indication contacts.

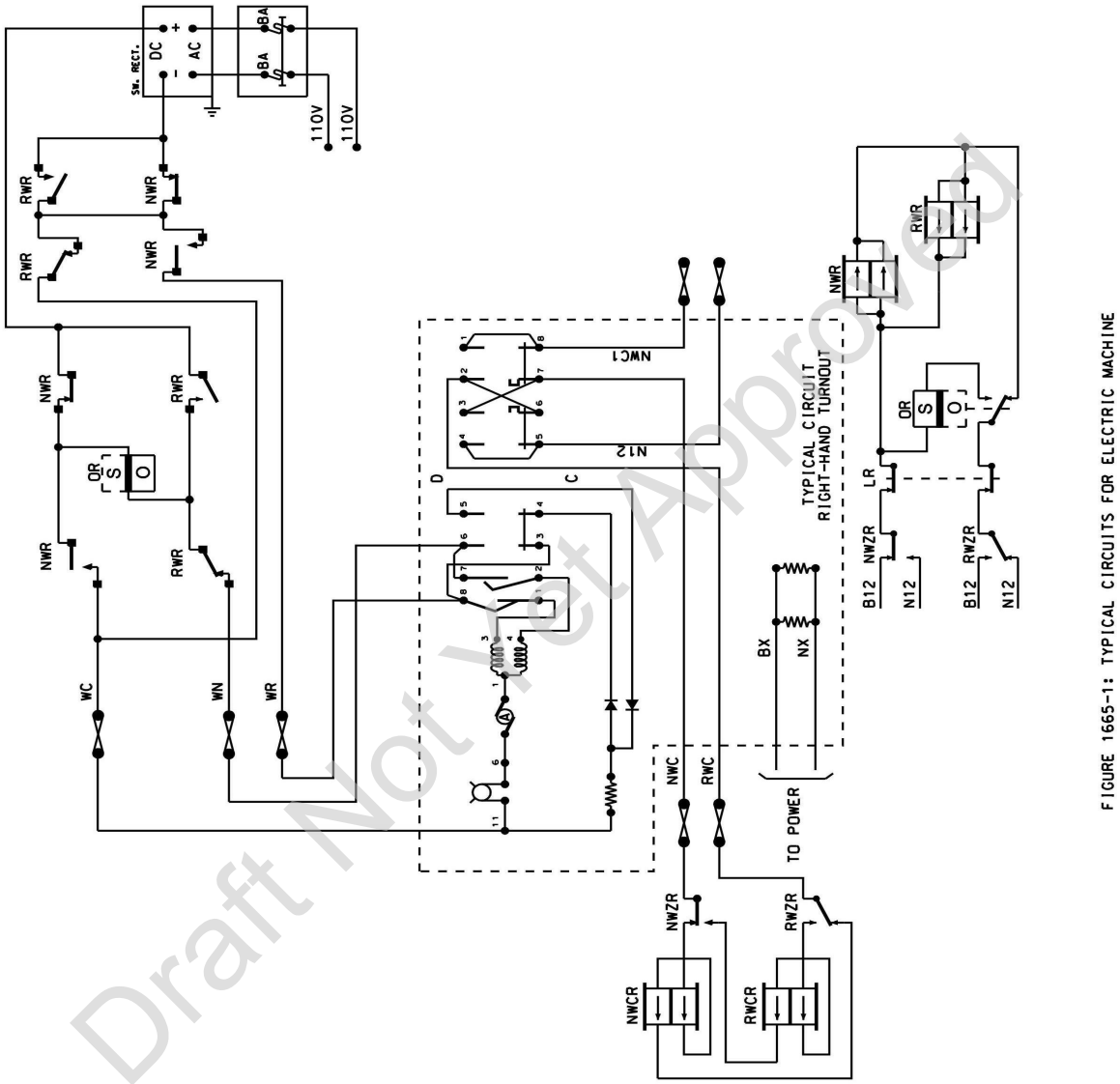

Figure 1665-1: Typical Circuits for Electric Switch Machine

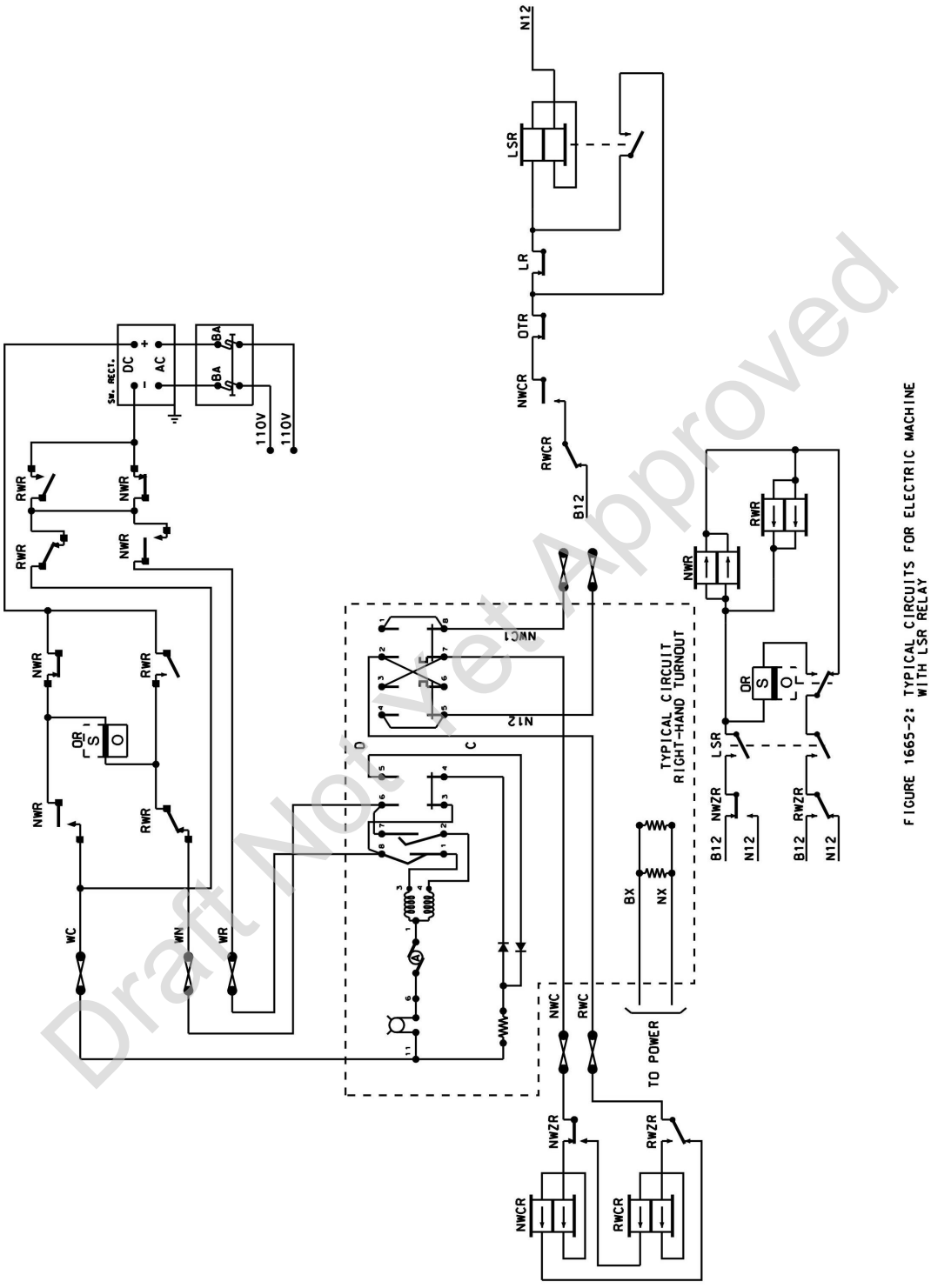

Figure 1665-2: Typical Circuits for Electric Switch Machine With LSR Relay