

Recommended Instructions for Direct-Current Relays

Revised 2023 (13 Pages)

A. Purpose

This Manual Part of recommended instructions apply to the installation, maintenance and testing of direct current, tractive armature type relays used in vital circuits.

These instructions set forth general requirements representing recommended practice. Relays of older or special design or having special characteristics must be installed and maintained in accordance with these instructions in so far as possible, and also in accordance with manufacturer's instructions.

B. Shop Tests and Inspections - General

1. Inspect and clean pivots and bearings, replacing any which are worn or defective.
2. Determine by actual operation that relay has a positive drop-away and contacts open without retardation of movement due to friction or any other cause.
3. Inspect gaskets and replace any found defective.
4. Insulation test shall be made between windings and between binding posts and relay frames. The insulation resistance shall not be less than 1 megohm.

If high potential tests are made, the voltage employed should be 80% of the value specified in applicable specifications for a new relay.

5. When taking current readings, voltmeter shall be disconnected. When taking voltage readings, voltmeter should be connected directly across the coils of the relay.
6. Inspect all screws, nuts and binding posts to determine that they are securely fastened, and lock washers where used are effective.
7. Before assembly is completed, relay and its cover shall be cleaned, as instructed, to remove any foreign matter.
8. Contacts of relay shall be tested for contact resistance after cover is in place and before relay is sealed.

9. Determine by observing operation of relay that at least 1/8 in (3.18 mm) clearance exists between cover and moving parts and that adequate clearance is provided between other fixed and moving parts.
10. Relay operating characteristics shall be determined as recommended in Section F and shall conform to shop requirements specified in Table 641-1. Record values on Form 641-1. If voltmeter readings are used, record ambient temperature under "Remarks".
11. Drop-away, pick-up and working values for neutral relays, or neutral armature drop-away, pick-up, reverse working values and normal and reverse polar pick-up and working value for the polarized relays, together with serial number, nominal resistance, type, date and inspector's initials shall be marked on Form 641-1 and fastened inside the relay cover where it can be read and in such a manner that it will not obscure or obstruct moving parts.
12. Meters shall be in calibration.
13. When repairing, relay shall be tested and inspected for defects, giving special attention to those noted on Form 641-4.

C. Coils

1. At +68 °F (+20 °C) the percentage variation in the resistance of individual coils shall not exceed:
 - a. For 5 ohms or less, $\pm 5\%$.
 - b. Above 5 ohms, $\pm 10\%$.
 - c. Correction for temperature variations should be made using curve, Figure 641-1.
2. Coils shall be secured in place to prevent damage due to vibration.

D. Contacts

1. Flexible connection from binding post to contact finger shall be formed and attached so as not to affect the operating characteristics of the relay.
2. Inspect and clean contacts, replacing any which are defective.

3. Finger contacts must meet fixed contact surfaces squarely and at the same time.
4. Metal support of the non-fusible contact element shall not come within 1/16 in (1.58 mm) of the contact surface.
5. Front and polar contact openings shall be per manufacturers' standard but shall not be less than 0.050 in (1.27 mm).
6. Back contact openings with front contacts just closing shall be per manufacturers' standard, but shall not be less than 0.020 in (0.51 mm).
7. Contact openings for special conditions shall be as instructed.
8. The contact resistance shall not exceed the following values, per contact when measured with 1 ampere through contacts:
 - a. For front contacts, when relay is energized at working current or voltage:
 - (1) Silver to silver, 0.03 ohm.
 - (2) Silver to carbon, 0.18 ohm.
 - (3) Silver to silver impregnated carbon, 0.09 ohm.
 - (4) Carbon to carbon, 0.40 ohm.
 - (5) Silver impregnated carbon to silver impregnated carbon, 0.20 ohm.
 - b. For back contacts, when relay is de-energized:
 - (1) Silver to silver, 0.03 ohm.
 - (2) Silver to carbon, 0.36 ohm.
 - (3) Silver to silver impregnated carbon, 0.18 ohm.
 - (4) Carbon to carbon, 0.80 ohm.
 - (5) Silver impregnated carbon to silver impregnated carbon, 0.40 ohm.

E. Armature

1. End play of armature shall be not less than 0.010 in (0.25 mm) nor more than 0.020 in (0.51 mm).
2. Relays shall have a minimum physical air gap for the neutral armature of 0.013 in (0.33 mm). The non-adjustable safety stop under each core shall protrude not less than 0.010 in (0.25 mm) from the underside of the core or the upper side of the relay armature. For the polar armature a minimum physical air gap of 0.013 in (0.33 mm) for a relay with two normal and two reverse polar contacts and of 0.006 in (0.15 mm) for a relay with four normal and four reverse polar contacts shall be maintained.

F. Operating Characteristics

1. Drop-away, pick-up and working values of neutral relays shall be determined in the normal direction of energization (relay is energized in the normal direction when the energy is applied with the polarity as marked on relay coil terminals), as follows:
 - a. An initial current as specified in Table 641-1 shall be applied to the coils and then gradually reduced until all front contacts first open. This value is termed "drop-away".
 - b. The circuit shall then be opened for 1 second and current again applied to the coils in the same direction and gradually increased until the front contacts just close. This value is termed "pick-up".
 - c. The current shall then be gradually increased until the armature is against the stop. This value is termed "working".
2. Drop-away, pick-up and working values of polarized relays shall be determined as follows:
 - a. An initial current as specified in Table 641-1 shall be applied to the coils in the normal direction and then gradually reduced until all neutral front contacts first open. This value is termed "neutral armature drop-away".
 - b. The circuit shall then be opened for 1 second and current again applied to the coils in the same direction and gradually increased until all front contacts of neutral armature just close. This value is termed "neutral armature pick-up".
 - c. The current shall then be gradually increased until the neutral

- armature is against the stop. This value is termed "neutral armature normal working".
- d. The current shall then be increased to initial value mentioned in Section F.2.a and then decreased to zero. Circuit shall then be opened for 1 second and current applied in reverse direction, gradually increasing from zero until the polar armature reverses. At this value the polar armature should go against its stop. This value is termed "reverse polar pick-up and working".
 - e. Increase the current gradually until the neutral armature is against the stop. This value is termed "neutral armature reverse working".
 - f. The current shall then be increased to initial value mentioned in Section F.2.a and then decreased to zero. Circuit shall then be opened for 1 second and current applied in normal direction, gradually increasing from zero until the polar armature returns to normal. At this value the polar armature shall go against its stop. This value is termed "normal polar pick-up and working".
 - g. After obtaining normal polar pick-up and working values, continue to increase the energy in the same direction until neutral armature is against its stop. This value shall not exceed that specified for neutral armature reverse working.
 - h. Polar armatures shall remain in last energized position without current in either direction in the coils.
3. When relay operation is checked by voltmeter, the coil temperature shall be determined and readings corrected to the normal temperature of +68 °F (+20 °C) for which operating values are established, by using curve, Figure 641-1.

G. Records, Test, Shipping

1. Relays should be identified by serial number, which should be recorded. Manufacturer's serial number should be used if available; otherwise, a number should be assigned by proper authority.
2. Relay cover shall be sealed.
3. Final drop-away, pick-up and working value tests shall be made after relay is sealed. The values obtained should not vary more than 2% from those of the previous tests.

4. Each relay should be in a separate carton or suitably protected before being placed in packing box for shipping.

H. Field Tests and Inspections - General

1. The normal functioning of any device shall not be disturbed, without first taking measures to provide for safety of train operation that depends on normal functioning of such device. Temporary work, repairs or adjustments, when required, shall be made in such a manner that safety of train operation shall not be impaired. When repair, adjustment, change or replacement is made, tests shall be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments shall be used and it shall be known that no unsafe conditions are created by the application of testing equipment.
2. When relay operation is checked by voltmeter, the coil temperature shall be determined and readings corrected to the nominal temperature of +68 °F (+20 °C) for which operating values are established, by using curve, Figure 641-1.
3. Relay operating characteristics shall be in accordance with field requirements specified in Table 641-1.
4. When taking current readings, voltmeter shall be disconnected. When taking voltage readings, voltmeter should be connected directly across the coils of the relay.
5. Determine by actual operation that relay has a positive drop-away and relay contacts open without retardation of movement due to friction or any other cause.
6. Inspect all screws, nuts and binding posts to determine that they are securely fastened and lock washers where used are effective.
7. Determine by observation that normal front, back and polar contact openings exist in all possible energized and de-energized states.
8. Determine by observing operation of relay that normal clearance exists between cover and moving parts and between all visible fixed and moving parts.
9. Enclosed relay parts shall be free from foreign material.
10. Relays not meeting field requirements shall be removed from service as soon as practicable and defects noted on Form 641-4.

11. Relays, when placed in service, shall meet shop requirements specified in Table 641-1, except in an emergency when relays meeting field requirements may be used.
12. Meters shall be checked frequently and recalibrated when necessary.
13. Inspector shall record field reading on Form 641-2 which, when complete, should be forwarded as instructed. If voltmeter readings are used, record ambient temperature under "Remarks."
14. Field reading should be transferred from Form 641-2 to Form 641-1, as instructed. One Form 641-1 should be used for each relay.

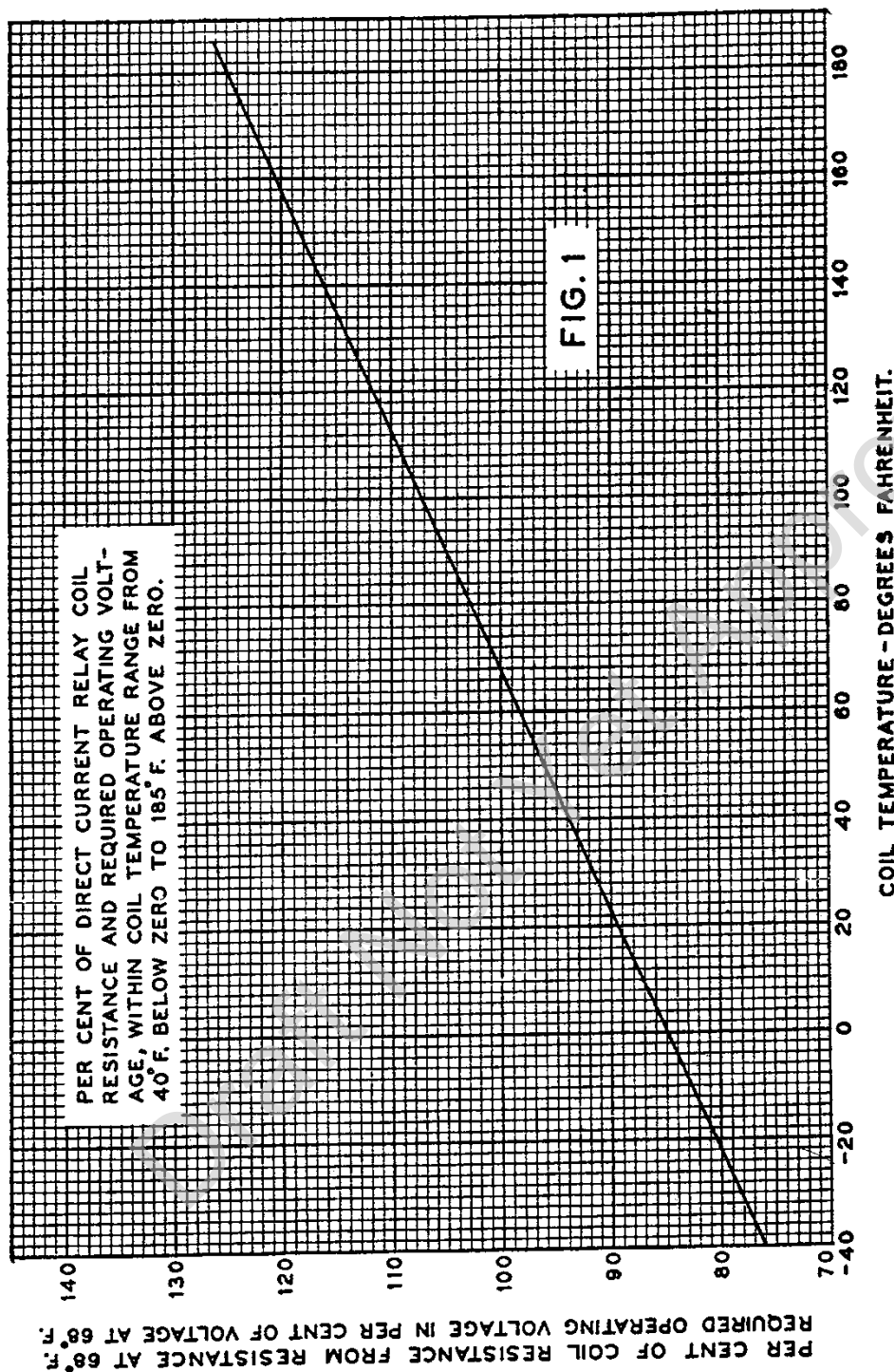
I. Installation

1. Operating characteristics of new and shopped relays shall be in accordance with shop requirements specified in Table 641-1.
2. Operating characteristics of relays retained in service shall be in accordance with field requirements specified in Table 641-1.
3. Make certain that all shipping screws, ties and blocking have been removed prior to placing relay into service.
4. By visual inspection, make certain that armatures of relays move freely and that moving contacts meet the fixed contact surfaces squarely and at the same time.
5. Make certain that timing relays are set and tested at not less than predetermined time interval shown on approved plans. The predetermined time setting should be so indicated on the relay.

Table 641-1: Recommended Operating Characteristics of Tractive-Armature Direct-Current Relays

	Shop Requirements		Field Requirements	
	NEUTRAL RELAYS	POLARIZED RELAYS	NEUTRAL RELAYS	POLARIZED RELAYS
Initial charge	Four times pick-up	Four times pick-up	Service working current or voltage	Reverse working current or voltage
Drop-away value (See Note 1)	Not less than 90% of original marking nor less than 43% of pick-up	Not less than 90% of original marking nor less than 43% of pick-up	TRACK RELAYS—Not less than 67% of original marking and in no case less than: (a) 35 milliamperes for 2-ohm relay (b) 25 milliamperes for 4-ohm relay LINE RELAYS—Not less than 67% of original marking	TRACK RELAYS—Not less than 67% of original marking and in no case less than: (a) 35 milliamperes for 2-ohm relay (b) 25 milliamperes for 4-ohm relay LINE RELAYS—Not less than 67% of original marking
Drop-away value (See Note 2)	Not less than 95% of original marking	Not less than 95% of original marking	TRACK RELAYS—Not less than 85% of original marking and in no case less than: (a) 45 milliamperes for 2-ohm relay (b) 32 milliamperes for 4-ohm relay LINE RELAYS—Not less than 67% of original marking	TRACK RELAYS—Not less than 85% of original marking and in no case less than: (a) 45 milliamperes for 2-ohm relay (b) 32 milliamperes for 4-ohm relay LINE RELAYS—Not less than 67% of original marking
Normal pick-up value	Not more than 110% of original marking	Not more than 110% of original marking	Not more than 110% of original marking	Not more than 110% of original marking
Normal working value	Not more than 110% of original marking	Not more than 110% of original marking	Not more than 110% of original marking	Not more than 110% of original marking
Reverse working value		Not more than 110% of original marking		Not more than 110% of original marking
Normal and reverse polar pick-up and working value		Not more than 70% of pick-up of neutral armature		Not more than 80% of pick-up of neutral armature

Note 1: These values are for relays having iron magnetic structure.
 Note 2: These values are for relays having silicon steel magnetic structure.



- Notes:**
1. Marked coil resistance is for 68 degrees Fahrenheit. Resistance at other coil temperature may be determined from this curve—or coil temperature may be determined from measured resistances at unknown temperature and at 68 degrees Fahrenheit.
 2. Relays are marked with operating voltages at 68 degrees Fahrenheit. When tested using voltmeter, readings must be corrected for existing coil temperature using this curve.

Figure 641-1: Recommended Correction for Temperature Variations

Form 641-2: Recommended Field Test Record of DC Electrical Apparatus

Form 6.4.1-2

FIELD TEST RECORD OF DC ELECTRICAL APPARATUS

DATE: ____/____/20____ NO. _____ INSPECTOR _____

LOCATION	CIRCUIT	SERIAL NO.	APPARATUS (REVERSE WORKING VALUES FOR POLARIZED RELAYS ONLY)		NEUTRAL ARMATURE				POLAR ARMATURE				REMARKS OR ORDER REF.							
			TYPE	RES.	NO. CONTACTS	DROP- AWAY	PICK- UP	WORKING		NO. CONTACTS	PICK- UP	SERVICE								
								NORMAL	REVERSE			NOR.		REV.	NORMAL	REVERSE				
			AMPS	VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS	VOLTS								

8"

$\frac{1}{4}$ "

$\frac{1}{2}$ " 2" 5" 2" $\frac{1}{2}$ "

$\frac{3}{8}$ "

Form 641-3: Recommended DC Relay Record Tags

Form 6.4.1-3A

NEUTRAL ARMATURE		POLAR ARMATURE		SER. NO.
D.A. --- V. ---	A. NOR. WKG. --- V. ---	A. N.P.U. --- Y. ---	A. OHMS	
P.U. --- V. ---	A. REV. WKG. --- V. ---	A. R.P.U. --- V. ---	A. BY:	20

6.4.1-3A

4"

19/32"

3/16"

Form 6.4.1-3B

DROP-AWAY		PICK-UP		WORKING		SER. NO.
VOLTS	AMPS.	VOLTS	AMPS.	VOLTS	AMPS.	OHMS
						BY: 20

6.4.1-3B

3"

19/32"

3/16"

Form 641-4: Recommended Repair Tag

FRONT OF YELLOW TAG

Form 6.4.1-4

REPAIR TAG

To _____

(USE ONE TAG FOR EACH INSTRUMENT OR PART)

4 3/4"

BACK OF YELLOW TAG

REPAIR TAG

KIND	TYPE	NUMBER

(STATE DEFECTS OR REASONS FOR RETURNING INSTRUMENT)

DATE _____ 20____ FROM _____ SIGNED _____

OVER
2 3/8"

3/16" Hole Reinforced