16. APTA PR-E-RP-017-99 Recommended Practice for 27-Point Control and Communication Trainlines for Locomotives and Locomotive-Hauled Equipment

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Abstract: This document defines the Recommended Practices for 27-point MU control and communication trainlines, including functional hardware and interfaces on the vehicles with circuit functions, for use on new/rebuilt locomotives and locomotives-hauled vehicles.

Keywords: control command, trainline, 27-point

Participants

The American Public Transportation Association greatly appreciates the contributions of the following individual(s), who provided the primary effort in the drafting of the *Recommended Practice for 27-Point Control and Communication Trainline for Locomotives and Locomotive-Hauled Equipment.*

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Contents

APTA PR-E-RP-017-99
Recommended Practice for 27-Point Control and Communication Trainlines for Locomotives and Locomotive-Hauled Equipment

1. Overview

1.1 Scope

This document defines the Recommended Practices for 27-point MU control and communication trainlines, including functional hardware (e.g. jumpers and receptacles) and interfaces on the vehicles with circuit functions, for use on new/rebuilt locomotives and locomotives-hauled vehicles.

Document *APTA PR-E-RP-019-00*[1] covers associated 27-point Jumper and Hardware Recommended Practices.

1.2 Purpose

The purpose of this document is to define 27-point jumper cable and associated receptacle contact functions and installation requirements on vehicles so as to allow intermixing of cars and locomotives of varying designs while maintaining mechanical and electrical compatibility of the trainline systems.

For special functions not already in general use, it is recommended that the specifying entity, be it an authority or railroad, approach APTA for a recommendation as to how to address the property-specific functions.

When developing new equipment specifications, it is highly advised that a careful review between the specifying authority and operating railroad(s) be made of the trainline control system requirements (both electrical and mechanical) to identify any subtle issues that may not be contained in this document.

2. References

AAR S-512-1994, 27-Point Control Plug and Receptacle Standard

APTA PR-E-RP-009-98, Recommended Practice for Wire Used on Passenger Rolling Stock

APTA PR-E-RP-002-98, Recommended Practice for Wiring of Passenger Equipment

APTA PR-E-S-001-98, Standard for Insulation Integrity

APTA PR-E-RP-019-99, Recommended Practice for 27-point Jumper and Receptacle Hardware

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For references in Italics, see Section 2.

3. Definitions abbreviations and acronyms

3.1 Definitions

3.1.1 27-Point jumper cable: A cable assembly, having a 27-conductor plug on one or both ends, which is used to provide a flexible electrical connection between two cars and/or locomotives.

3.1.2 27-Point receptacle: The receptacle(s) mounted on the ends of rail vehicles into which the 27-point jumper cables mate.

3.1.3 jumper, fixed: A cable assembly, having a 27-conductor plug on one end and the other end permanently fixed to the vehicle, which is used to provide a flexible electrical connection between two cars and/or locomotives.

3.1.4 looping: The process of connecting a jumper cable between two adjacent receptacles on the same vehicle. This is normally done on the exposed end of the last car of a train and establishes circuits identifying that point as the end of the train for various trainline circuits.

3.1.5 power car: For the purposes of this recommended practice a vehicle which serves the propulsion and/or head end power purpose(s) of a locomotive but is part of a semi-permanently coupled trainset. Typically, only one end of a power car is suitable to be attached to the train.

3.1.6 receptacle, dummy: A receptacle that is used to hold the free end of an unconnected jumper cable. The dummy may include contact(s) to establish end-of-train circuit functions for the trainline, or it may be a purely passive device with no contacts.

3.1.7 trainline: For the purposes of this recommended practice, an electrical cable system that allows electrical signals to be sent over the entire length of the train. Types include power, control, communication and data, often with more than one function contained within the same cable. The trainline may connect to equipment in each vehicle, or may simply pass through, providing a signal path between vehicles on opposite ends of that vehicle.

3.1.8 trainline, car control/communication: A trainline (referred to within this document as "Communication") whose function is primarily to convey car control and communication signals throughout the train. Typical signals include: door controls and indications, public address, brake applied/ released indications, etc.

3.1.9 trainline, multiple unit (MU): A trainline whose primary function is to convey traction and dynamic brake commands and indications. This trainline is used to provide those signals between:

- Locomotives coupled together
- Cab car and locomotive
- Locomotives or power cars placed at opposite ends of the train

4. General

4.1 Purpose of 27-point trainlines

An electrical trainline allows a single point in the train to issue commands to all or some of the vehicles simultaneously. Likewise, indications are provided from one or more points in the consist to a central monitoring point.

4.2 Types of trainlines

The two types of 27-point trainlines defined in this document are listed below. Normally, operation of these two types of trainlines is completely independent.

4.2.1 MU (multiple unit)

This trainline is used to convey signals relating to traction, dynamic brake and traction/locomotive status indications among locomotives of a consist. In push-pull consists, it is used to convey these signals between cab car operator console and the locomotive.

Vehicles conforming to this recommended practice are generally compatible with most freight locomotive MU trainlines (as defined in *AAR S-512-1994*). Individual railroad rules and operating practices govern intermixing of this equipment.

Electric locomotives equipped for push/pull service are equipped with two MU trainline systems.

One system (identified White) is currently used exclusively between some electric locomotives. The White system uses an analog throttle control.

The second (identified Black) is used exclusively between cab cars and electric locomotives. The black trainline employs send/receive "diesel" digital throttle logic. The use of the "Black" MU system for push/pull allows universal use of cab cars with both diesel and electric locomotives, without the requirement for two different types of MU trainlines systems on all cars.

4.2.2 Communication

This trainline is used to convey control and indication signals, as well as audio (for public address, intercom, etc.) throughout the consist. Most of the functions reside only within the passenger cars, however several signals are conveyed to the locomotive and cab car to indicate train status for such items as brakes applied/released.

4.3 Configurations

A single jumper cable for a given type of trainline is required at vehicle-to-vehicle coupling. Refer to Figure 1.

4.3.1 MU Trainline system configurations

4.3.1.1 General

– 27 conductor trainline

- 74 VDC nominal voltage, ungrounded
- Voltage source from locomotive
- On/ off commands/ indications except for two (2) analog

4.3.1.2 Locomotives:

- 4 MU receptacles, two on each end of locomotive
- 1 MU jumper coupled between units when two or more locomotives are coupled
- Receptacle arrangement and location per Figures 2 and 3
- Conductor function assignment per Tables 1, 3 or 4

4.3.1.3 Power cars:

- 2 MU receptacles, on the end connected to the rest of the consist
- Receptacle arrangement and location per Figures 2 and 3
- Conductor function assignment per Tables 1, 3 or 4

4.3.1.4 Cars equipped for push/ pull operation:

- 4 MU receptacles, two per end (one receptacle per end is permissible, but not recommended because cars cannot be turned end-for-end)
- 1 MU jumper coupled between adjacent vehicles
- Receptacle arrangement and location per Figures 2 and 4
- Conductor function assignment per Tables 2, 5 or 6

Note: The MU trainline connects to equipment only on locomotives, power cars and cab cars, and merely passes through other intermediate vehicles.

4.3.2 Communication trainline system configurations

4.3.2.1 General

- 27 conductor trainline
- 74 VDC nominal voltage, grounded negative
- Shields for audio wiring grounded at one point only per vehicle
- On/ off commands/ indications
- Audio analog signals on balanced lines

4.3.2.2 Locomotives

- 4 communication receptacles, two on each end of locomotive
- 1 communication jumper coupled between units when two or more locomotives are coupled
- Receptacle arrangement and location per Figures 2 and 3
- Conductor function assignment per Tables 8 or 9

4.3.2.3 Power cars

- 2 communication receptacles
- Receptacle arrangement and location per Figures 2 and 3
- Conductor function assignment per Tables 8 or 9

4.3.2.4 Cars

- 4 communication receptacles, two per end (one receptacle per end is permissible, but not recommended because cars cannot be turned end-for-end)
- 1 communication jumper coupled between adjacent vehicles
- Receptacle arrangement and location per Figures 2 and 4
- Conductor function assignment per Tables 8 or 9

Note-- Generally, the communication trainline connects to functions on all passenger carrying cars and passes through non-passenger cars, such as express equipment. Some but not all functions connect to equipment in the locomotive; this typically includes indications of train status, such as all brakes released, door closed, etc.

5. Application to vehicles

5.1 End location (left/right/both)

The location of the receptacles on the end of the vehicle should conform to Figures 3 or 4.

5.1.1 Locomotives

Receptacles for a given function (MU, car control, etc.) should be provided on all four corners of the locomotive. Exception: The black MU trainline receptacle is only required on two diagonal corners of electric locomotives (front right and left rear positions).

5.1.2 Power cars

Receptacles for a given function (MU, car control, etc.) should be provided on both sides of the train end of the power car, to allow it to be used on either end of the consist.

5.1.3 Cars

Receptacles for a given function (MU, car control, etc.) should be provided, at a minimum, on both ends of a car, and, for a given function, on the same side of the car. (For example, the MU cable system might be only on the left side of the car and the communication cable only on the right side.) On intercity passenger cars, the receptacles should be located on all four corners of the car to allow the cars to be rotated end-for-end. On all other cars, it is strongly recommended both trainline systems be applied to all four corners of each car.

5.2 Provisions for future installation

If the trainline is installed on one side of the car only, provisions should be provided for future installation on the second side, which include: receptacle mounting hole covered with a blanking plate, conduit for wiring and sufficient room in the junction boxes to add the additional receptacle wiring.

5.3 Mounting

The plate to which the receptacles (and jumper flanges, if used) are mounted should be reinforced to resist, without bending, forces produced from pulling the locked jumper out of the receptacle, such as by an unauthorized uncoupling. The jumper cable should be sacrificial relative to the car body components under these conditions.

Receptacle mounting should be such that there is adequate clearance between jumpers, receptacles and uncoupling rods, diaphragm/buffer, couplers, air hoses, etc. Variables include:

- Coupler motion horizontally and vertically
- Relative motion to adjacent vehicle, in curve, passing through crossover, in buff and draft, etc.
- Whether jumper is inserted into receptacle or not

There should be no interference that restricts the receptacle cover from being fully opened to allow insertion or withdrawal of jumpers.

5.4 Keying and identification

Receptacles and jumper cables should be keyed, color coded and labeled per paragraph 4.1 of *APTA PR-E-RP-019-00*[2] to prevent cables having different functions from being cross-connected. Labeling should be provided on the receptacle cover and/or adjacently on the car body.

5.5 Junction boxes

A stainless steel junction box, equipped with stud type terminal blocks, should be provided near the end of each vehicle to provide for the connection of the receptacle pigtails with the vehicle car body wiring. The terminal blocks for different functions MU, communication, etc., should be

[2] For references in Italics, see Section 2.

physically separate. Individual terminals should be permanently labeled for each specific wire name.

5.6 Car wire routing

5.6.1 End to end

Wiring practice should generally conform to *APTA PR-E-RP-002-98, Recommended Practice for Wiring Passenger Equipment*, with the following additional requirements:

- Wiring connecting the 27-point receptacles from one end of the vehicle to the other should be run in conduit or equivalent.

- Where trainline wires are required to cross, (such as forward and reverse wires), this should occur at the B-end (rear) of the vehicle.

- The wiring for the different types of trainline systems (MU and communication) should be mechanically separated, including separate conduits, so as to minimize the risk of EMI and to prevent accidental cross connection, either from installation or from mechanical injury sustained in service.

- The routing of the trainline cables, particularly under car, should be selected so as to ensure it is well protected from mechanical damage, especially from wayside debris.

5.7 Wiring

5.7.1 Standards

Wire should conform to *APTA PR-E-RP-009-98, Recommended Practice for Wire Used on Passenger Rolling Stock.*

5.7.2 Terminations

The preferred method of termination should be with vibration-resistant, ring-tongue, and crimp type lugs.

5.7.3 Continuity

All like pins of the trainline cable systems should have continuity between all like receptacles, whether the function is currently in use or not.

5.7.4 Spare circuit availability

In addition, all 27 wires of each of the trainline systems should be brought within the vehicle to suitable terminal blocks so current spares are easily available for future assignment.

5.7.5 Spare wires end to end

All undesignated function pins and conductors should be marked as spare wires and should be installed between end-of-car junction boxes for each trainline cable system. Spare or unused wires should not be grounded.

6. Testing

6.1 Wiring

6.1.1 Insulation

The requirements for tests are those contained in *APTA PR-E-S-001-98, Standard for Insulation Integrity.*

6.1.2 Continuity

Tests should be undertaken to ensure that:

- Continuity exists between all intended contacts of all receptacles
- Continuity exists between trainlines and each vehicle connection to the trainline circuits
- No wires are unintentionally grounded
- No wires are shorted or cross-connected to unintended circuits

6.1.3 Functional tests

In addition, each conductor of each trainline should be exercised to ensure the equipment to which it is connected transmits/receives the trainline signal correctly.

6.2 Proof-of-design

An engineering Proof-of-Design type test should be conducted on the new vehicles.

6.2.1 New vehicle tests

At a minimum, a pair of vehicles should be tested, but should there be more than one vehicle type, all types should be included in the test. In addition, new vehicles should be tested with all types of existing vehicles with which the new equipment is to be operated.

6.2.2 Functional tests

These tests should include operating each conductor of each trainline in all possible modes of operation (including new car to existing car and the reverse, existing car to new car), to demonstrate proper functioning of all controls and indications.

6.2.3 Cable swing and interference

In addition, receptacle and jumper location and potential interference with coupler, uncoupling rods, diaphragm/buffer, couplers, air hoses, etc. should be checked while:

- Manipulating jumpers into and out of receptacles
- Swinging coupler

– Curve test of two (or more) coupled vehicles through minimum radius curve and sharpest crossovers in both buff and draft.

7. Wire function tables

7.1 Categories of function

The following tables identify wire functions in two categories:

– Pre-Assigned, and

– Suggested Use

7.1.1 Pre-assigned wire functions

"Pre-Assigned" functions are those for which a wire is exclusively assigned for all vehicles, regardless of whether the function itself exists on the vehicle. For example, dynamic brake functions may not be installed on a specific locomotive, but the wires in the trainline will be assigned exclusively for that function and cannot be used for other purposes.

7.1.2 Suggested use wire functions

"Suggested Use" is a function which is currently in use on some vehicles, and if those vehicles are to be intermixed with other model vehicles, the same function must be assigned. These wire functions are herein designated as “Spare”, with suggested function, if any, in parenthesis.

7.1.3 Diesel MU AAR trainline standard

The diesel locomotive MU configuration is based on the *AAR Standard S-512-1994*, and will allow inter-mating of APTA standard locomotives with most freight locomotive types.

7.1.4 Communication trainline conventions

Two alternate communication trainline functionality conventions have been provided. The intercity version (Table 8) provides a convention suited for long haul or commuter equipment. The commuter version (Table 9) provides an alternative that is already in use in a number of commuter-type operations.

8. Illustrations

8.1 Tables

1. MU System for Diesel-Electric Locomotives
2. MU System for Cab Car Compatible to Diesel-Electric Locomotive
3. MU System for Electric Locomotives
4. MU System for Electric Locomotive equipped for Diesel Logic Cab Car Control
5. MU System for Dual Mode Cab Car Compatible with: Diesel-Electric or Electric Loco

6. MU System for Car Pass-Through

7. (Reserved for future use.)

8. Communication System for Intercity Equipment

9. Communication System for Commuter Equipment

8.2 Figures

1. Typical Consist 27-point Jumper Cable Arrangement

2. 27-point Receptacle Positions

3A. Standard Locations: End of Vehicle Trainline Connectors – Locomotive F-end

3B. Standard Locations: End of Vehicle Trainline Connectors – Locomotive B-end

4A. Standard Locations: End of Vehicle Trainline Connectors – Low-level Car

4B. Standard Locations: End of Vehicle Trainline Connectors – High-level Car

Table 1 MU System for Diesel-Electric Locomotives

27 POINT MU FUNCTION CHART (BLACK RECEPTACLE)

PIN#	WIRE DESIGNATION	WIRE GAUGE	FUNCTION NAME	VOLTAGE RANGE (VDC)	FUNCTION	CURRENT REQUIRED (MA)
1	SP	14	SPARE (RESERVED FOR CRUISE CONTROL)	–	NA	
2	SG	14	ALARM BELL	74	C/I	
3	DV	14	D THROTTLE	74	C	
4	N	10	CONTROL NEGATIVE [1]	0	–	
5	ES	14	EMERGENCY SAND	74	C	
6	GF	12	GENERATOR FIELD	74	C	
7	CV	14	C THROTTLE	74	C	
8	FO	12	FOWARD	74	C	
9	RE	12	REVERSE	74	C	
10	WS	14	WHEEL SLIP	74	I	
11	SP	14	SPARE	–	NA	
12	BV	14	B THROTTLE	74	C	
13	PC	12	CONTROL POSITIVE [2]	74	–	
14	SP	14	SPARE (RESERVED FOR ZERO SPEED BYPASS)	–	NA	
15	AV	14	A THROTTLE	74	C	
16	ER	14	ENGINE RUN	74	C	
17	B	14	DYNAMIC BRAKE SET UP	74	C	
18	RLC	12	REMOTE LOADMETER [3]	–	I	0–100mA
19	RLD	12	REMOTE LOADMETER [3]	–	I	0–100mA
20	BW	14	DYNAMIC BRAKE WARNING	74	I	
21	BG	14	DYNAMIC BRAKE START	74	C	
22	CC	14	COMPRESSOR SYNCHRONIZATION	–	NA	
23	SA	14	MANUAL SAND	74	C/I	
24	BC	14	DYNAMIC BRAKE EXCITATION [3]	0–74	C	
25	HLS	12	MU HEADLIGHT	74	C	
26	SV	14	REMOTE RESET	74	C	
27	SP	14	SPARE	–	NA	

NOTES :

UNLESS NOTED, ALL SIGNALS ARE OFF–ON MAINTAINED AT 0 OR 74 VDC.

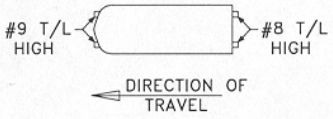
FUNCTION
C=COMMAND
I=INDICATION
A=AUDIO

NOTES :

[1] THE NEGATIVE SIDE OF EACH LOCOMOTIVE IS COMMON TO ALL LOCOMOTIVES VIA THIS WIRE.

[2] THE LEAD LOCOMOTIVE FEEDS +74 V TO TRAILING UNITS VIA THIS WIRE.

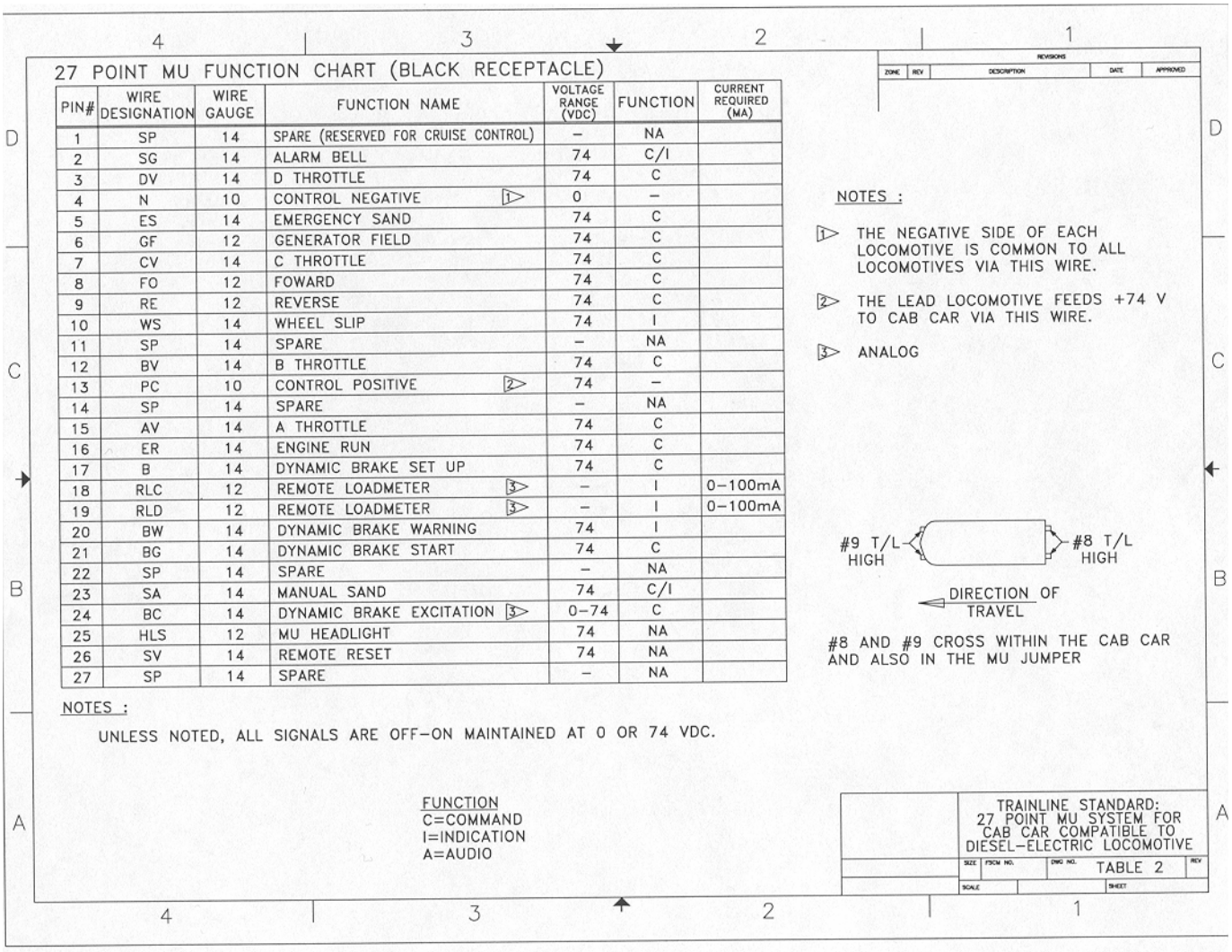
[3] ANALOG



#8 AND #9 CROSS WITHIN THE LOCOMOTIVE AND ALSO IN THE MU JUMPER

TRAINLINE STANDARD:
27 POINT MU SYSTEM FOR
DIESEL–ELECTRIC LOCOMOTIVES
TABLE 1

Table 2 MU System for Cab Car Compatible to Diesel-Electric Locomotive



27 POINT MU FUNCTION CHART (BLACK RECEPTACLE)

PIN#	WIRE DESIGNATION	WIRE GAUGE	FUNCTION NAME	VOLTAGE RANGE (VDC)	FUNCTION	CURRENT REQUIRED (MA)
1	SP	14	SPARE (RESERVED FOR CRUISE CONTROL)	–	NA	
2	SG	14	ALARM BELL	74	C/I	
3	DV	14	D THROTTLE	74	C	
4	N	10	CONTROL NEGATIVE [1]	0	–	
5	ES	14	EMERGENCY SAND	74	C	
6	GF	12	GENERATOR FIELD	74	C	
7	CV	14	C THROTTLE	74	C	
8	FO	12	FOWARD	74	C	
9	RE	12	REVERSE	74	C	
10	WS	14	WHEEL SLIP	74	I	
11	SP	14	SPARE	–	NA	
12	BV	14	B THROTTLE	74	C	
13	PC	10	CONTROL POSITIVE [2]	74	–	
14	SP	14	SPARE	–	NA	
15	AV	14	A THROTTLE	74	C	
16	ER	14	ENGINE RUN	74	C	
17	B	14	DYNAMIC BRAKE SET UP	74	C	
18	RLC	12	REMOTE LOADMETER [3]	–	I	0–100mA
19	RLD	12	REMOTE LOADMETER [3]	–	I	0–100mA
20	BW	14	DYNAMIC BRAKE WARNING	74	I	
21	BG	14	DYNAMIC BRAKE START	74	C	
22	SP	14	SPARE	–	NA	
23	SA	14	MANUAL SAND	74	C/I	
24	BC	14	DYNAMIC BRAKE EXCITATION [3]	0–74	C	
25	HLS	12	MU HEADLIGHT	74	NA	
26	SV	14	REMOTE RESET	74	NA	
27	SP	14	SPARE	–	NA	

NOTES :

UNLESS NOTED, ALL SIGNALS ARE OFF–ON MAINTAINED AT 0 OR 74 VDC.

FUNCTION
C=COMMAND
I=INDICATION
A=AUDIO

NOTES :

[1] THE NEGATIVE SIDE OF EACH LOCOMOTIVE IS COMMON TO ALL LOCOMOTIVES VIA THIS WIRE.

[2] THE LEAD LOCOMOTIVE FEEDS +74 V TO CAB CAR VIA THIS WIRE.

[3] ANALOG

#9 T/L HIGH — #8 T/L HIGH

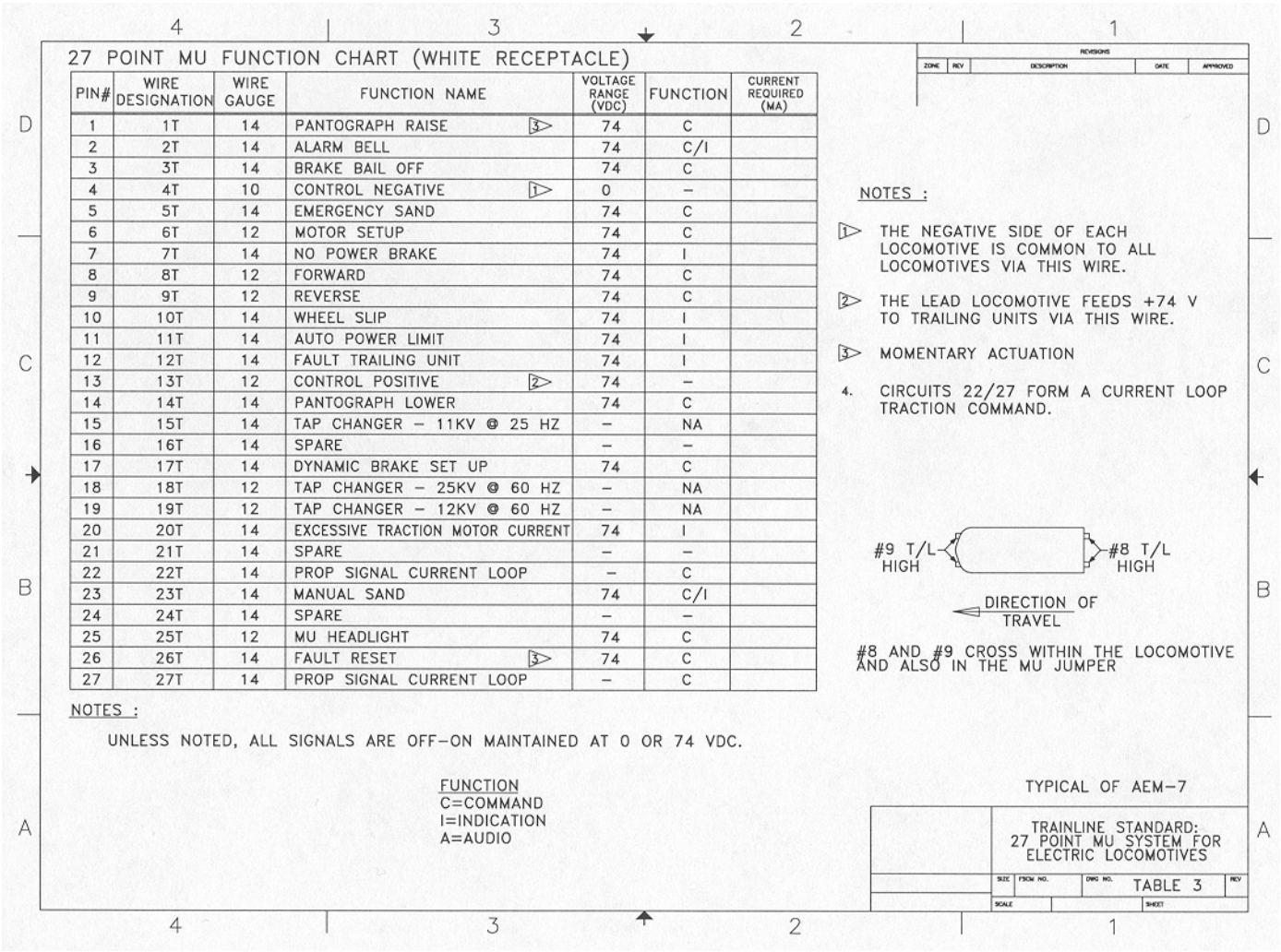
DIRECTION OF TRAVEL

#8 AND #9 CROSS WITHIN THE CAB CAR AND ALSO IN THE MU JUMPER

TRAINLINE STANDARD:
27 POINT MU SYSTEM FOR CAB CAR COMPATIBLE TO DIESEL–ELECTRIC LOCOMOTIVE

TABLE 2

Table 3 MU System for Electric Locomotives



27 POINT MU FUNCTION CHART (WHITE RECEPTACLE)

PIN#	WIRE DESIGNATION	WIRE GAUGE	FUNCTION NAME	VOLTAGE RANGE (VDC)	FUNCTION	CURRENT REQUIRED (MA)
1	1T	14	PANTOGRAPH RAISE ③	74	C	
2	2T	14	ALARM BELL	74	C/I	
3	3T	14	BRAKE BAIL OFF	74	C	
4	4T	10	CONTROL NEGATIVE ①	0	–	
5	5T	14	EMERGENCY SAND	74	C	
6	6T	12	MOTOR SETUP	74	C	
7	7T	14	NO POWER BRAKE	74	I	
8	8T	12	FORWARD	74	C	
9	9T	12	REVERSE	74	C	
10	10T	14	WHEEL SLIP	74	I	
11	11T	14	AUTO POWER LIMIT	74	I	
12	12T	14	FAULT TRAILING UNIT	74	I	
13	13T	12	CONTROL POSITIVE ②	74	–	
14	14T	14	PANTOGRAPH LOWER	74	C	
15	15T	14	TAP CHANGER – 11KV @ 25 HZ	–	NA	
16	16T	14	SPARE	–	–	
17	17T	14	DYNAMIC BRAKE SET UP	74	C	
18	18T	12	TAP CHANGER – 25KV @ 60 HZ	–	NA	
19	19T	12	TAP CHANGER – 12KV @ 60 HZ	–	NA	
20	20T	14	EXCESSIVE TRACTION MOTOR CURRENT	74	I	
21	21T	14	SPARE	–	–	
22	22T	14	PROP SIGNAL CURRENT LOOP	–	C	
23	23T	14	MANUAL SAND	74	C/I	
24	24T	14	SPARE	–	–	
25	25T	12	MU HEADLIGHT	74	C	
26	26T	14	FAULT RESET ③	74	C	
27	27T	14	PROP SIGNAL CURRENT LOOP	–	C	

NOTES :

UNLESS NOTED, ALL SIGNALS ARE OFF–ON MAINTAINED AT 0 OR 74 VDC.

FUNCTION
C=COMMAND
I=INDICATION
A=AUDIO

NOTES :

① THE NEGATIVE SIDE OF EACH LOCOMOTIVE IS COMMON TO ALL LOCOMOTIVES VIA THIS WIRE.

② THE LEAD LOCOMOTIVE FEEDS +74 V TO TRAILING UNITS VIA THIS WIRE.

③ MOMENTARY ACTUATION

4. CIRCUITS 22/27 FORM A CURRENT LOOP TRACTION COMMAND.

#9 T/L HIGH — #8 T/L HIGH

DIRECTION OF TRAVEL

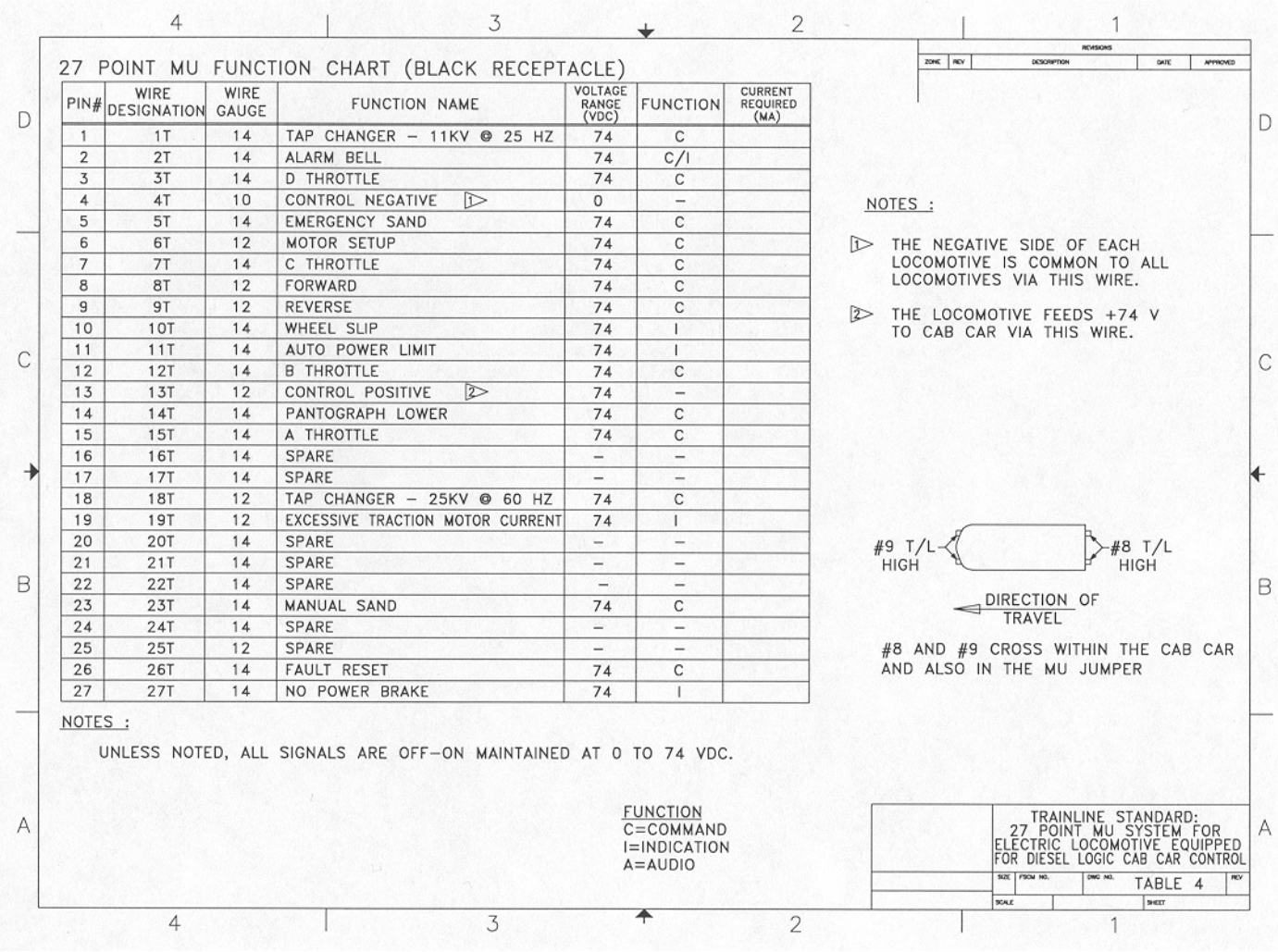
#8 AND #9 CROSS WITHIN THE LOCOMOTIVE AND ALSO IN THE MU JUMPER

TYPICAL OF AEM–7

TRAINLINE STANDARD:
27 POINT MU SYSTEM FOR ELECTRIC LOCOMOTIVES

TABLE 3

Table 4 MU System for Electric Locomotive Equipped for Diesel Logic Cab Car Control



27 POINT MU FUNCTION CHART (BLACK RECEPTACLE)

PIN#	WIRE DESIGNATION	WIRE GAUGE	FUNCTION NAME	VOLTAGE RANGE (VDC)	FUNCTION	CURRENT REQUIRED (MA)
1	1T	14	TAP CHANGER – 11KV @ 25 HZ	74	C	
2	2T	14	ALARM BELL	74	C/I	
3	3T	14	D THROTTLE	74	C	
4	4T	10	CONTROL NEGATIVE ▷1	0	–	
5	5T	14	EMERGENCY SAND	74	C	
6	6T	12	MOTOR SETUP	74	C	
7	7T	14	C THROTTLE	74	C	
8	8T	12	FORWARD	74	C	
9	9T	12	REVERSE	74	C	
10	10T	14	WHEEL SLIP	74	I	
11	11T	14	AUTO POWER LIMIT	74	I	
12	12T	14	B THROTTLE	74	C	
13	13T	12	CONTROL POSITIVE ▷2	74	–	
14	14T	14	PANTOGRAPH LOWER	74	C	
15	15T	14	A THROTTLE	74	C	
16	16T	14	SPARE	–	–	
17	17T	14	SPARE	–	–	
18	18T	12	TAP CHANGER – 25KV @ 60 HZ	74	C	
19	19T	12	EXCESSIVE TRACTION MOTOR CURRENT	74	I	
20	20T	14	SPARE	–	–	
21	21T	14	SPARE	–	–	
22	22T	14	SPARE	–	–	
23	23T	14	MANUAL SAND	74	C	
24	24T	14	SPARE	–	–	
25	25T	12	SPARE	–	–	
26	26T	14	FAULT RESET	74	C	
27	27T	14	NO POWER BRAKE	74	I	

NOTES :

UNLESS NOTED, ALL SIGNALS ARE OFF–ON MAINTAINED AT 0 TO 74 VDC.

FUNCTION
C=COMMAND
I=INDICATION
A=AUDIO

NOTES :

▷1 THE NEGATIVE SIDE OF EACH LOCOMOTIVE IS COMMON TO ALL LOCOMOTIVES VIA THIS WIRE.

▷2 THE LOCOMOTIVE FEEDS +74 V TO CAB CAR VIA THIS WIRE.

#9 T/L HIGH — #8 T/L HIGH

DIRECTION OF TRAVEL

#8 AND #9 CROSS WITHIN THE CAB CAR AND ALSO IN THE MU JUMPER

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

TRAINLINE STANDARD:
27 POINT MU SYSTEM FOR ELECTRIC LOCOMOTIVE EQUIPPED FOR DIESEL LOGIC CAB CAR CONTROL

SIZE | FSCM NO. | DWG NO. TABLE 4 | REV

SCALE | SHEET

Table 5 MU System for Dual Mode Cab Car Compatible with: Diesel-Electric or Electric Loco

27 POINT MU FUNCTION CHART (BLACK RECEPTACLE)

PIN#	WIRE DESIGNATION	WIRE GAUGE	FUNCTION NAME	VOLTAGE RANGE (VDC)	FUNCTION	CURRENT REQUIRED (MA)
1	1T	14	TAP CHANGER – 11KV @ 25 HZ	74	C	
2	2T	14	ALARM BELL	74	C/I	
3	3T	14	D THROTTLE	74	C	
4	4T	10	CONTROL NEGATIVE ▷1	0	–	
5	5T	14	EMERGENCY SAND	74	C	
6	6T	12	GENERATOR FIELD	74	C	
7	7T	14	C THROTTLE	74	C	
8	8T	12	FORWARD	74	C	
9	9T	12	REVERSE	74	C	
10	10T	14	WHEEL SLIP	74	I	
11	11T	14	AUTO POWER LIMIT	74	I	
12	12T	14	B THROTTLE	74	C	
13	13T	12	CONTROL POSITIVE ▷2	74	–	
14	14T	14	PANTOGRAPH LOWER	74	C	
15	15T	14	A THROTTLE	74	C	
16	16T	14	ENGINE RUN	74	C	
17	17T	14	SPARE	–	–	
18	18T	12	TAP CHANGER – 25KV @ 60 HZ	74	C	
19	19T	12	EXCESSIVE TRACTION MOTOR CURRENT	74	I	
20	20T	14	DYNAMIC BRAKE WARNING	74	I	
21	21T	14	SPARE	–	–	
22	22T	14	SPARE	–	–	
23	23T	14	MANUAL SAND	74	C/I	
24	24T	14	SPARE	–	–	
25	25T	12	SPARE	–	–	
26	26T	14	FAULT RESET	–	C	
27	27T	14	NO POWER BRAKE	74	I	

NOTES :

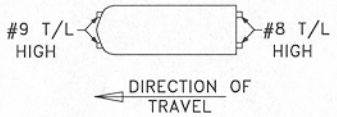
UNLESS NOTED, ALL SIGNALS ARE OFF–ON MAINTAINED AT 0 TO 74 VDC.

FUNCTION
C=COMMAND
I=INDICATION
A=AUDIO

NOTES :

▷1 THE NEGATIVE SIDE OF EACH LOCOMOTIVE IS COMMON TO ALL LOCOMOTIVES VIA THIS WIRE.

▷2 THE LOCOMOTIVE FEEDS +74 V TO THE CAB CAR VIA THIS WIRE.

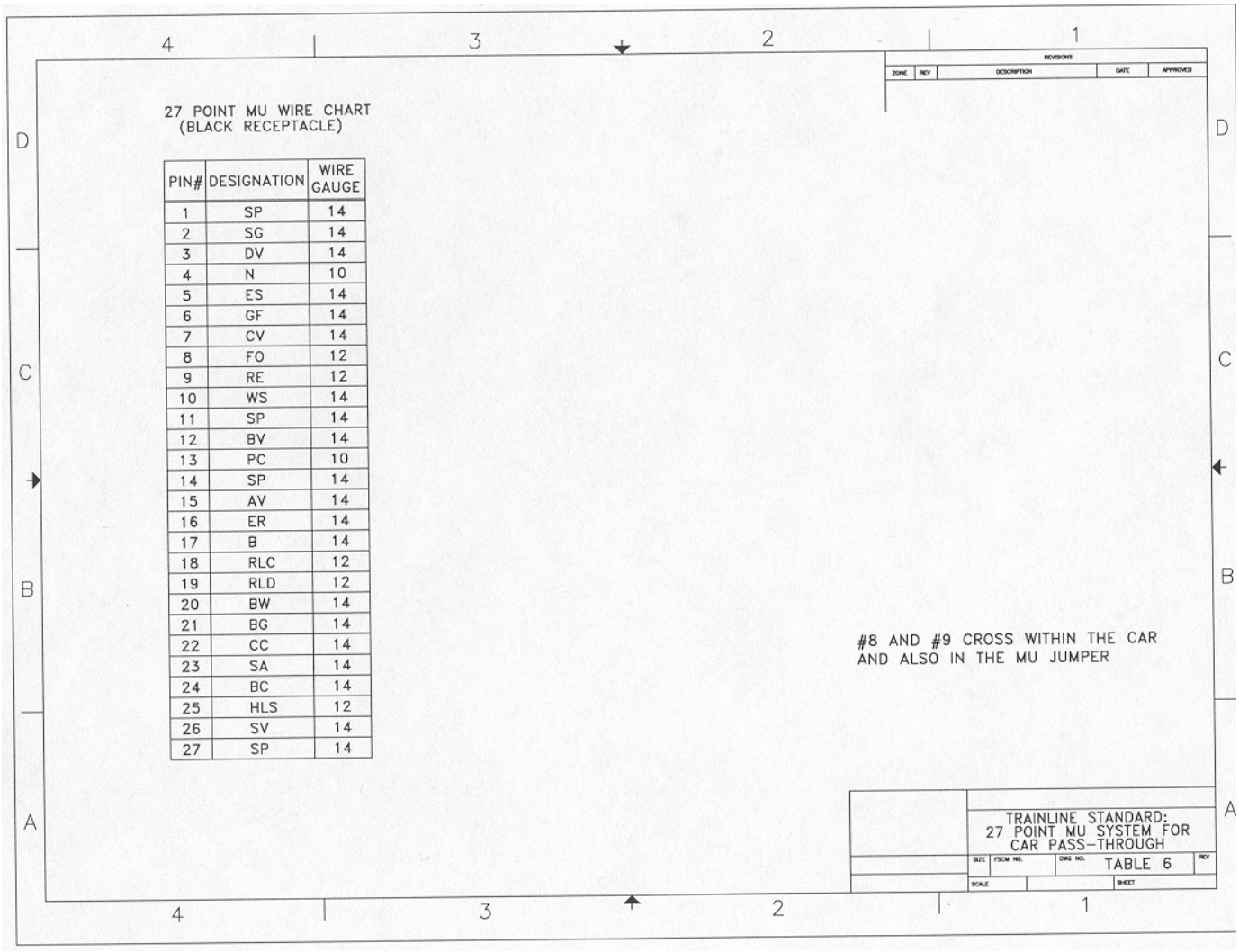


#8 AND #9 CROSS WTHIN THE CAB CAR AND ALSO IN THE MU JUMPER

REVISIONS
ZONE | REV | DESCRIPTION | DATE | APPROVED

TRAINLINE STANDARD:
27 POINT MU SYSTEM FOR
DUAL MODE CAB CAR:COMPATIBLE WITH
DIESEL–ELECTRIC OR ELECTRIC LOCO
SIZE | FSCM NO. | DWG NO. TABLE 5 | REV
SCALE | SHEET

Table 6 MU System for Car Pass-Through



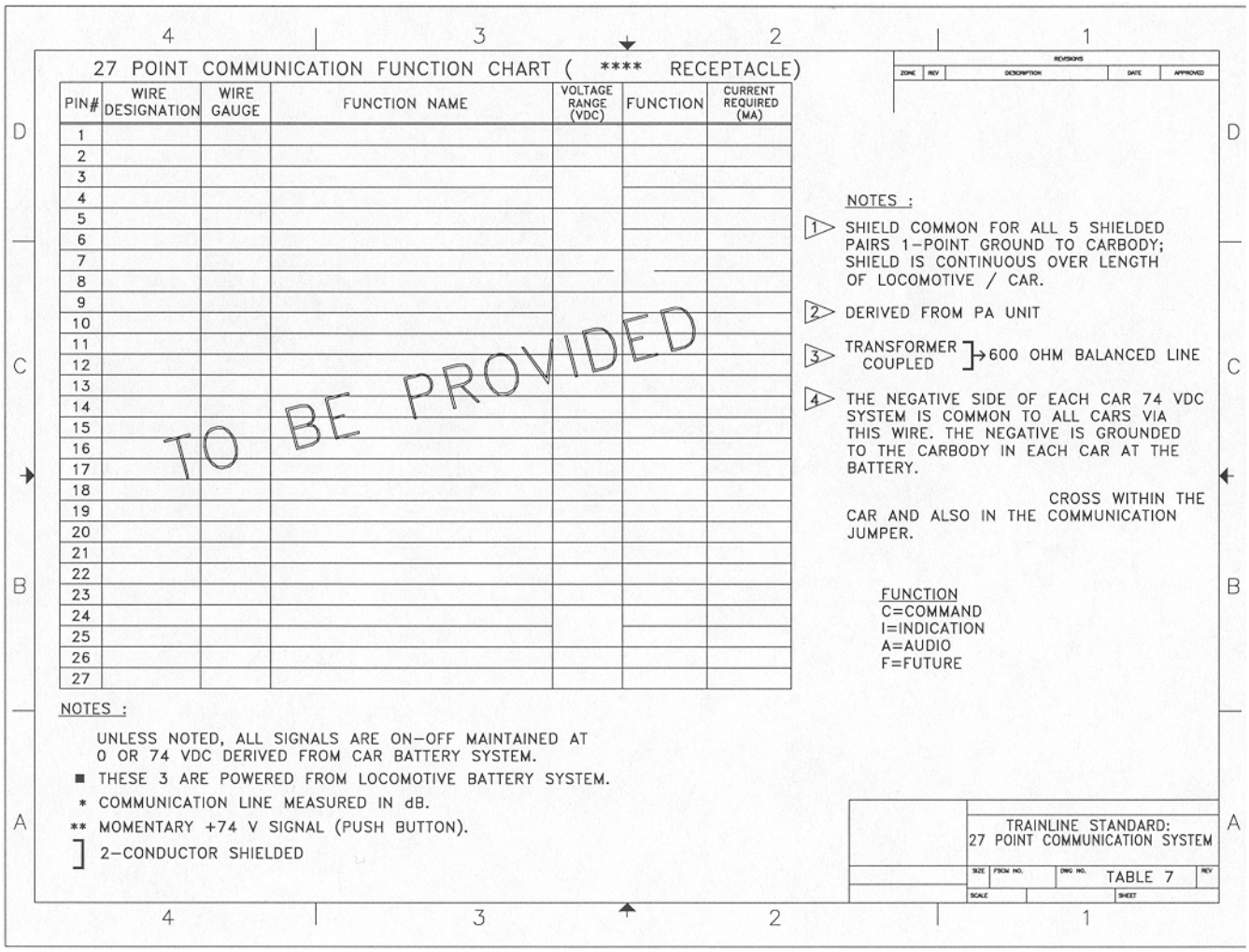
27 POINT MU WIRE CHART
(BLACK RECEPTACLE)

PIN#	DESIGNATION	WIRE GAUGE
1	SP	14
2	SG	14
3	DV	14
4	N	10
5	ES	14
6	GF	14
7	CV	14
8	FO	12
9	RE	12
10	WS	14
11	SP	14
12	BV	14
13	PC	10
14	SP	14
15	AV	14
16	ER	14
17	B	14
18	RLC	12
19	RLD	12
20	BW	14
21	BG	14
22	CC	14
23	SA	14
24	BC	14
25	HLS	12
26	SV	14
27	SP	14

#8 AND #9 CROSS WITHIN THE CAR
AND ALSO IN THE MU JUMPER

TRAINLINE STANDARD:
27 POINT MU SYSTEM FOR
CAR PASS-THROUGH
TABLE 6

Table 7 Trainline Standard



27 POINT COMMUNICATION FUNCTION CHART (**** RECEPTACLE)

PIN#	WIRE DESIGNATION	WIRE GAUGE	FUNCTION NAME	VOLTAGE RANGE (VDC)	FUNCTION	CURRENT REQUIRED (MA)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						

TO BE PROVIDED

NOTES :

UNLESS NOTED, ALL SIGNALS ARE ON–OFF MAINTAINED AT 0 OR 74 VDC DERIVED FROM CAR BATTERY SYSTEM.

■ THESE 3 ARE POWERED FROM LOCOMOTIVE BATTERY SYSTEM.

* COMMUNICATION LINE MEASURED IN dB.

** MOMENTARY +74 V SIGNAL (PUSH BUTTON).

] 2–CONDUCTOR SHIELDED

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES :

1. SHIELD COMMON FOR ALL 5 SHIELDED PAIRS 1–POINT GROUND TO CARBODY; SHIELD IS CONTINUOUS OVER LENGTH OF LOCOMOTIVE / CAR.
2. DERIVED FROM PA UNIT
3. TRANSFORMER COUPLED] → 600 OHM BALANCED LINE
4. THE NEGATIVE SIDE OF EACH CAR 74 VDC SYSTEM IS COMMON TO ALL CARS VIA THIS WIRE. THE NEGATIVE IS GROUNDED TO THE CARBODY IN EACH CAR AT THE BATTERY.

CROSS WITHIN THE CAR AND ALSO IN THE COMMUNICATION JUMPER.

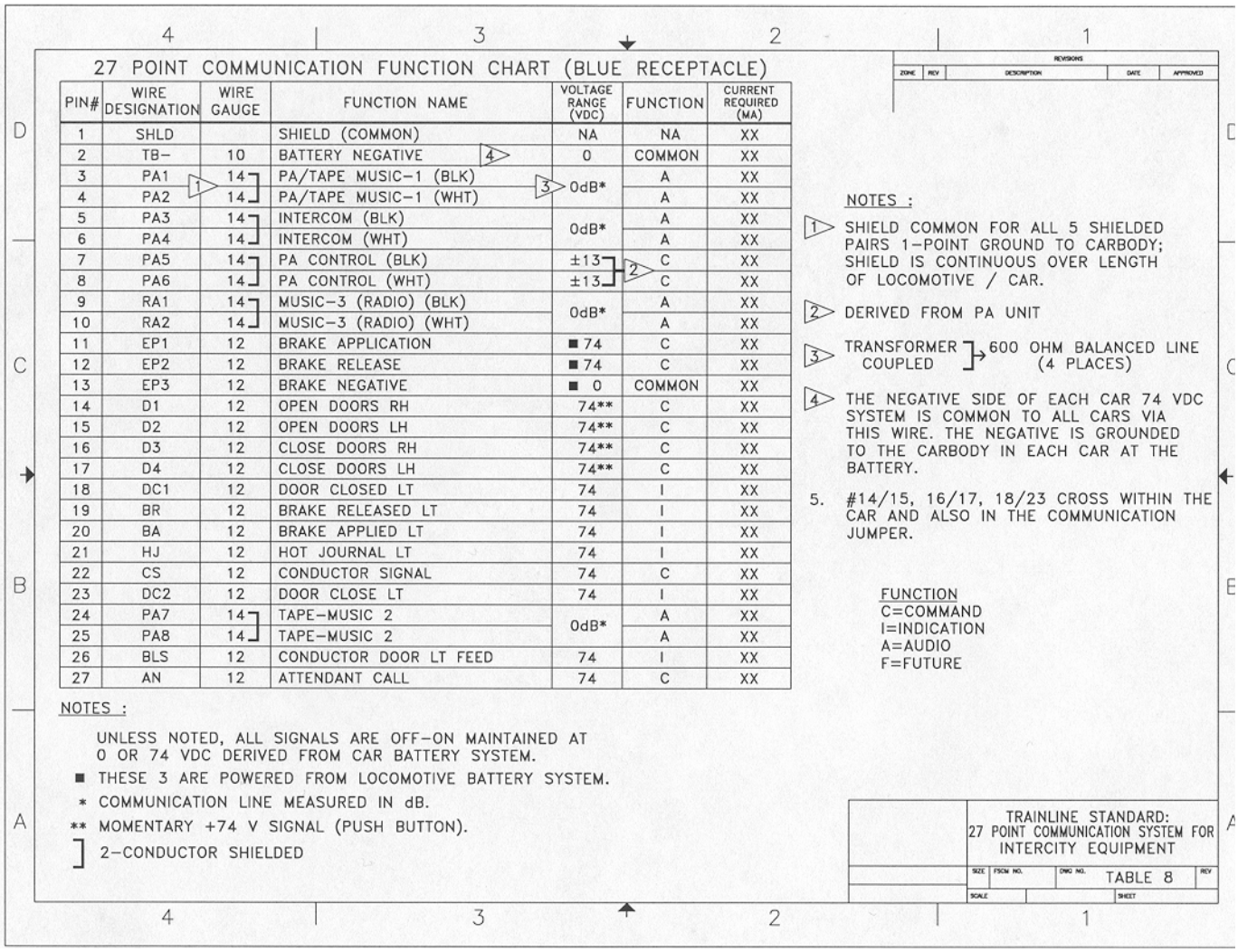
FUNCTION
C=COMMAND
I=INDICATION
A=AUDIO
F=FUTURE

TRAINLINE STANDARD:
27 POINT COMMUNICATION SYSTEM

SIZE | FSCM NO. | DWG NO. TABLE 7 | REV

SCALE | SHEET

Table 8 Communication System for Intercity Equipment



27 POINT COMMUNICATION FUNCTION CHART (BLUE RECEPTACLE)

PIN#	WIRE DESIGNATION	WIRE GAUGE	FUNCTION NAME	VOLTAGE RANGE (VDC)	FUNCTION	CURRENT REQUIRED (MA)
1	SHLD		SHIELD (COMMON)	NA	NA	XX
2	TB−	10	BATTERY NEGATIVE ④	0	COMMON	XX
3	PA1 ①	14]	PA/TAPE MUSIC−1 (BLK)	③ 0dB*	A	XX
4	PA2 ①	14]	PA/TAPE MUSIC−1 (WHT)		A	XX
5	PA3	14]	INTERCOM (BLK)	0dB*	A	XX
6	PA4	14]	INTERCOM (WHT)		A	XX
7	PA5	14]	PA CONTROL (BLK)	±13] ②	C	XX
8	PA6	14]	PA CONTROL (WHT)	±13]	C	XX
9	RA1	14]	MUSIC−3 (RADIO) (BLK)	0dB*	A	XX
10	RA2	14]	MUSIC−3 (RADIO) (WHT)		A	XX
11	EP1	12	BRAKE APPLICATION	■ 74	C	XX
12	EP2	12	BRAKE RELEASE	■ 74	C	XX
13	EP3	12	BRAKE NEGATIVE	■ 0	COMMON	XX
14	D1	12	OPEN DOORS RH	74**	C	XX
15	D2	12	OPEN DOORS LH	74**	C	XX
16	D3	12	CLOSE DOORS RH	74**	C	XX
17	D4	12	CLOSE DOORS LH	74**	C	XX
18	DC1	12	DOOR CLOSED LT	74	I	XX
19	BR	12	BRAKE RELEASED LT	74	I	XX
20	BA	12	BRAKE APPLIED LT	74	I	XX
21	HJ	12	HOT JOURNAL LT	74	I	XX
22	CS	12	CONDUCTOR SIGNAL	74	C	XX
23	DC2	12	DOOR CLOSE LT	74	I	XX
24	PA7	14]	TAPE−MUSIC 2	0dB*	A	XX
25	PA8	14]	TAPE−MUSIC 2		A	XX
26	BLS	12	CONDUCTOR DOOR LT FEED	74	I	XX
27	AN	12	ATTENDANT CALL	74	C	XX

NOTES :

UNLESS NOTED, ALL SIGNALS ARE OFF−ON MAINTAINED AT 0 OR 74 VDC DERIVED FROM CAR BATTERY SYSTEM.

■ THESE 3 ARE POWERED FROM LOCOMOTIVE BATTERY SYSTEM.

* COMMUNICATION LINE MEASURED IN dB.

** MOMENTARY +74 V SIGNAL (PUSH BUTTON).

] 2−CONDUCTOR SHIELDED

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES :

① SHIELD COMMON FOR ALL 5 SHIELDED PAIRS 1−POINT GROUND TO CARBODY; SHIELD IS CONTINUOUS OVER LENGTH OF LOCOMOTIVE / CAR.

② DERIVED FROM PA UNIT

③ TRANSFORMER COUPLED] → 600 OHM BALANCED LINE (4 PLACES)

④ THE NEGATIVE SIDE OF EACH CAR 74 VDC SYSTEM IS COMMON TO ALL CARS VIA THIS WIRE. THE NEGATIVE IS GROUNDED TO THE CARBODY IN EACH CAR AT THE BATTERY.

5. #14/15, 16/17, 18/23 CROSS WITHIN THE CAR AND ALSO IN THE COMMUNICATION JUMPER.

FUNCTION
C=COMMAND
I=INDICATION
A=AUDIO
F=FUTURE

TRAINLINE STANDARD:
27 POINT COMMUNICATION SYSTEM FOR INTERCITY EQUIPMENT

SIZE | FSCM NO. | DWG NO. TABLE 8 | REV
SCALE | SHEET

Table 9 Communication System for Commuter Equipment

27 POINT COMMUNICATION FUNCTION CHART (RED RECEPTACLE)

PIN#	WIRE DESIGNATION	WIRE GAUGE	FUNCTION NAME	VOLTAGE RANGE (VDC)	FUNCTION	CURRENT REQUIRED (MA)
1		12	ZERO SPEED	36	C	
2		12	ENABLE DOORS–LH	36**	C	
3		12	DOOR INTERLOCK	74 ■	C	
4		10	CAR BATTERY NEGATIVE 3	COMMON	COMMON	
5		12	SPARE	NA	F	
6		12	BUZZER POWER	36	C	
7		16	INTERCOM (BLK) 1 ▲	_dB*	A	
8		12	SPARE	NA	F	
9		16	PA/INTERCOM CONTROL (BLK)		C	
10		16	PA/INTERCOM CONTROL (WHT)		C	
11		12	ENABLE DOORS–RH	36**	C	
12		NA	INTERCOM (SHIELD) ▲	NA	NA	
13		16	INTERCOM (WHT) 1 ▲	_dB*	A	
14		12	DOOR CLOSED LIGHT	74 ■	C/I	
15		16	PA (BLK) 2 ▲	_dB*	A	
16		16	PA (SHIELD) ▲	NA	NA	
17		12	OPEN DOORS–LH	36**	C	
18		12	CLOSE DOORS–LH	36**	C	
19		10	CAB MU SUPPLY POSITIVE	+74V■	C	
20		16	PA (WHT) 2 ▲	_dB*	A	
21		12	CAR BUZZER	36**	C	
22		12	DOOR OVERRIDE	74 ■	C/I	
23		12	SPARE	NA	F	
24		10	CAR BATTERY POSITIVE	36	C	
25		12	SPARE (DOOR STATION ACTIVATED)	36	C	
26		12	CLOSE DOORS–RH	36**	C	
27		12	OPEN DOORS–RH	36**	C	

NOTES :

UNLESS NOTED, ALL SIGNALS ARE OFF–ON MAINTAINED AT 0 OR 36 VDC DERIVED FROM CAR BATTERY SYSTEM.

■ THESE ARE POWERED FROM LOCOMOTIVE BATTERY SYSTEM.

* COMMUNICATION LINE MEASURED IN dB.

** MOMENTARY +36 V SIGNAL (PUSH BUTTON).

▲ 2–CONDUCTOR SHIELDED

NOTES :

1. #7 & 13 WITH 12 AS SHIELD TRANSFORMER COUPLED → 150 OHM BALANCED LINE
2. #15 & 20 WITH 16 AS SHIELD TRANSFORMER COUPLED → 150 OHM BALANCED LINE
3. THE NEGATIVE SIDE OF EACH CAR 36 VDC SYSTEM IS COMMON TO ALL CARS VIA THIS WIRE.

2/11, 17/27 & 18/26 CROSS WITHIN THE CAR AND ALSO IN THE COMMUNICATION JUMPER.

FUNCTION
C=COMMAND
I=INDICATION
A=AUDIO
F=FUTURE

REVISIONS: ZONE | REV | DESCRIPTION | DATE | APPROVED

ALTERNATE TRAINLINE STANDARD: 27 POINT COMMUNICATION SYSTEM FOR COMMUTER EQUIPMENT
SIZE | FSCM NO. | DWG NO. TABLE 9 | REV
SCALE | SHEET

Figure 1 Typical Consist 27 point Jumper Cable Arrangement

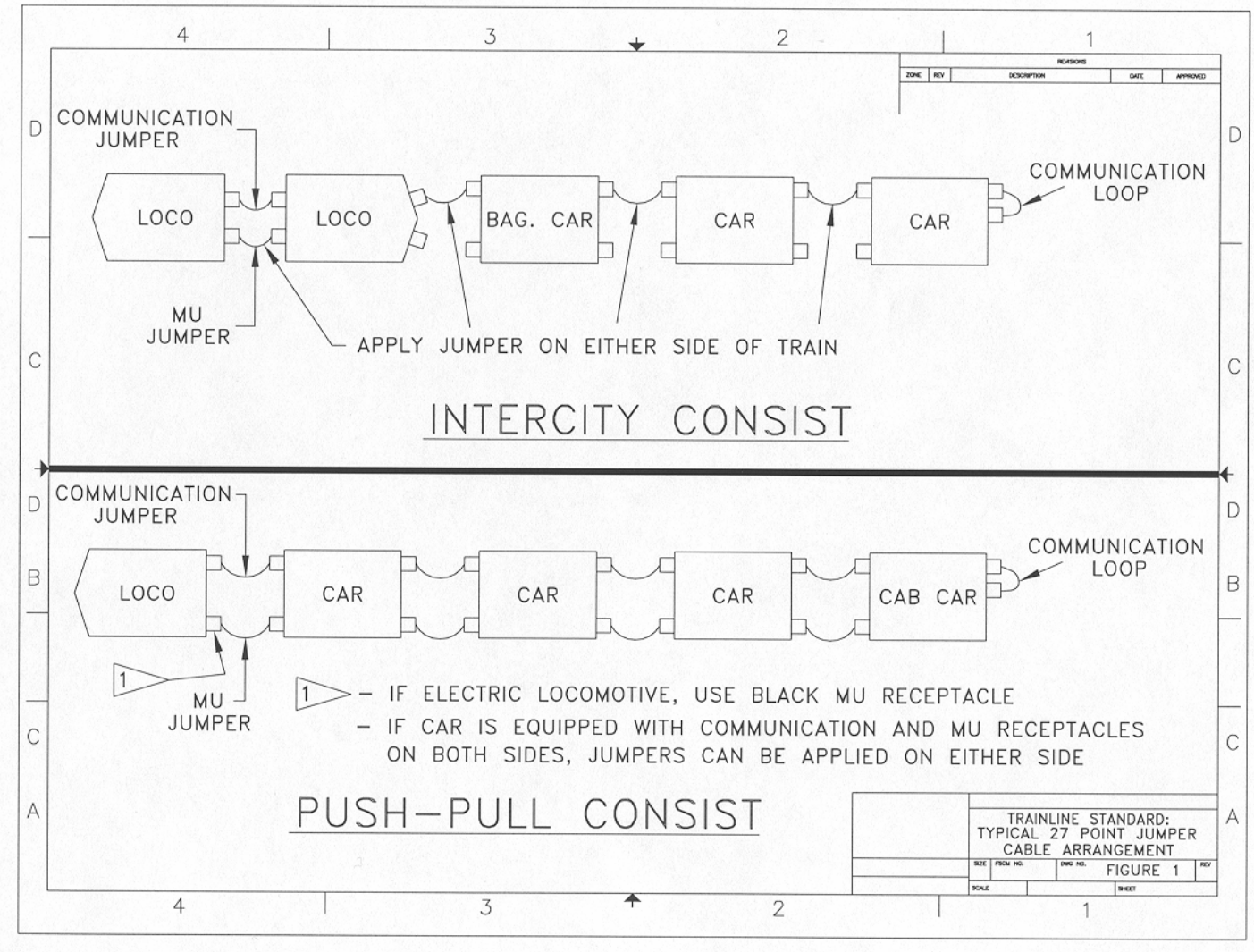


Figure 2 27-point Receptacle Positions

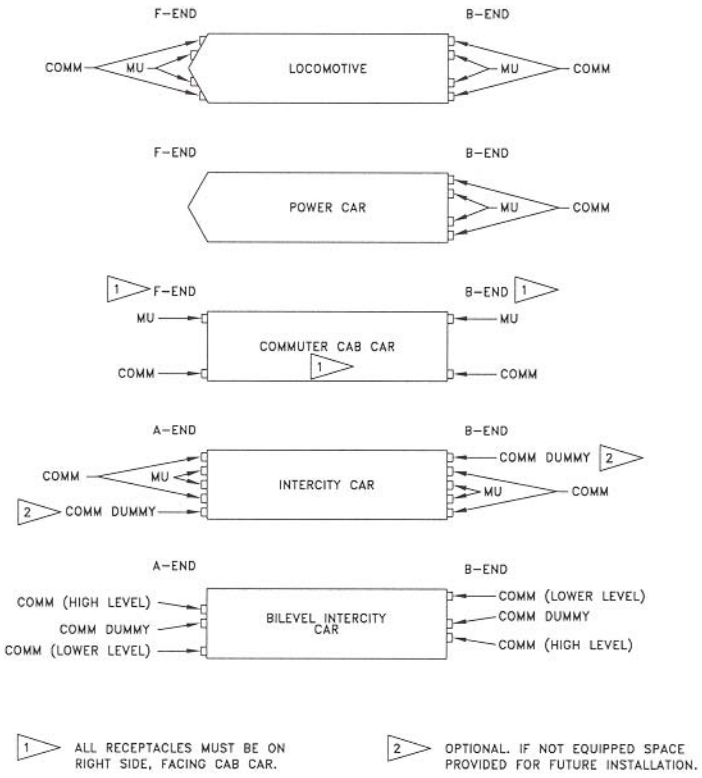
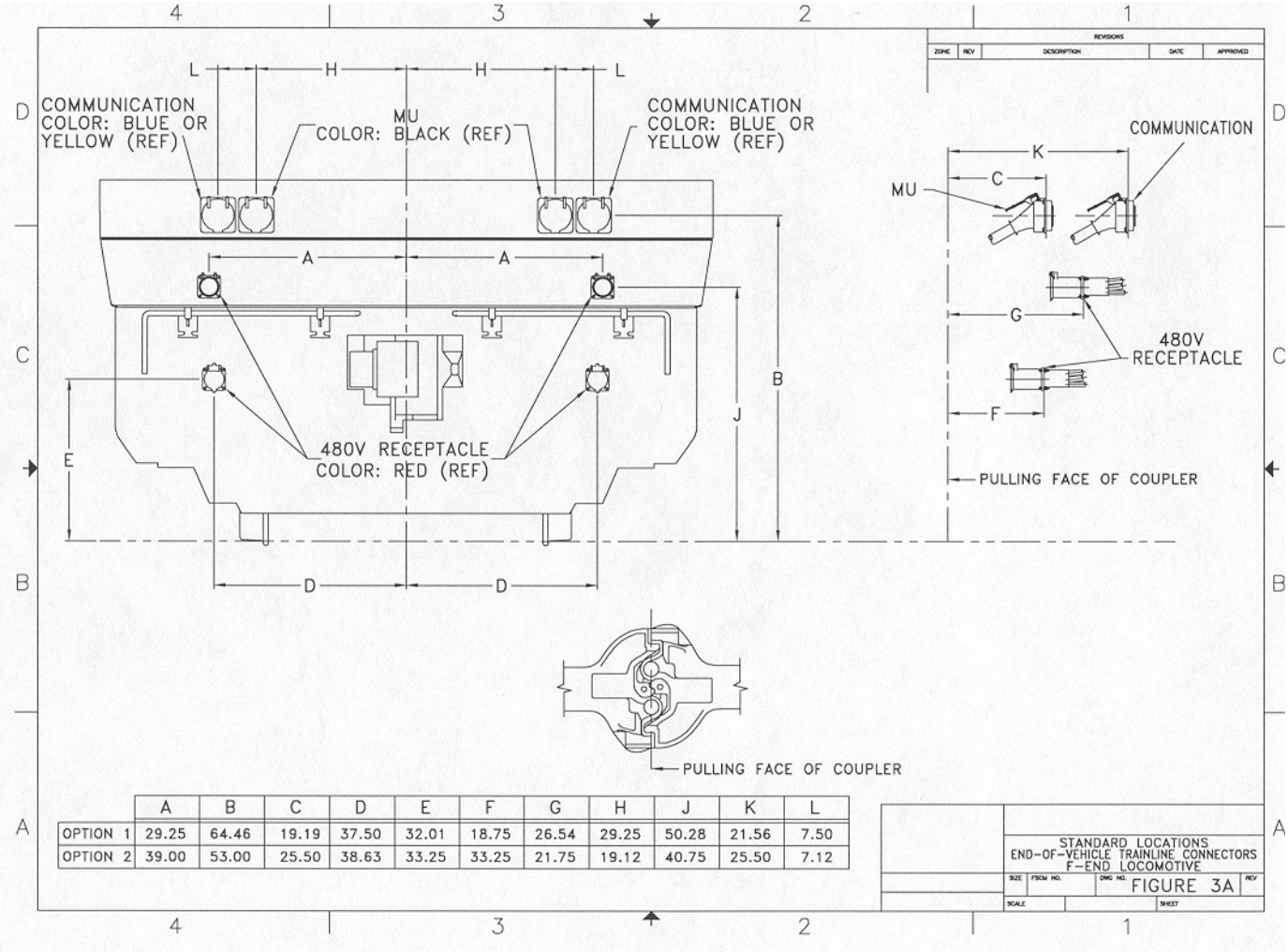


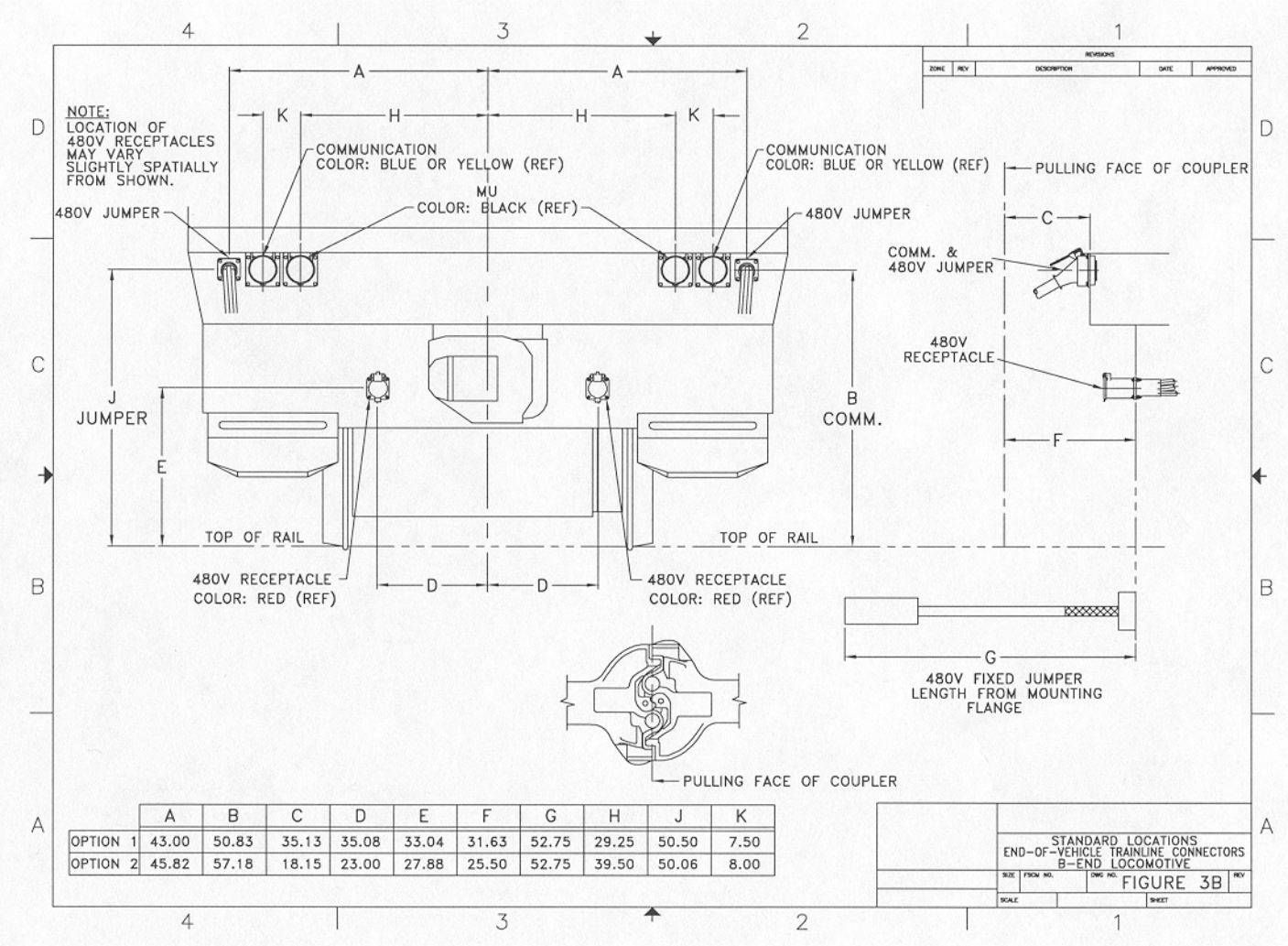
FIGURE 2 27 POINT RECEPTACLE POSITIONS

Figure 3A Standard Locations: End of Vehicle Trainline Connectors - Locomotive F end



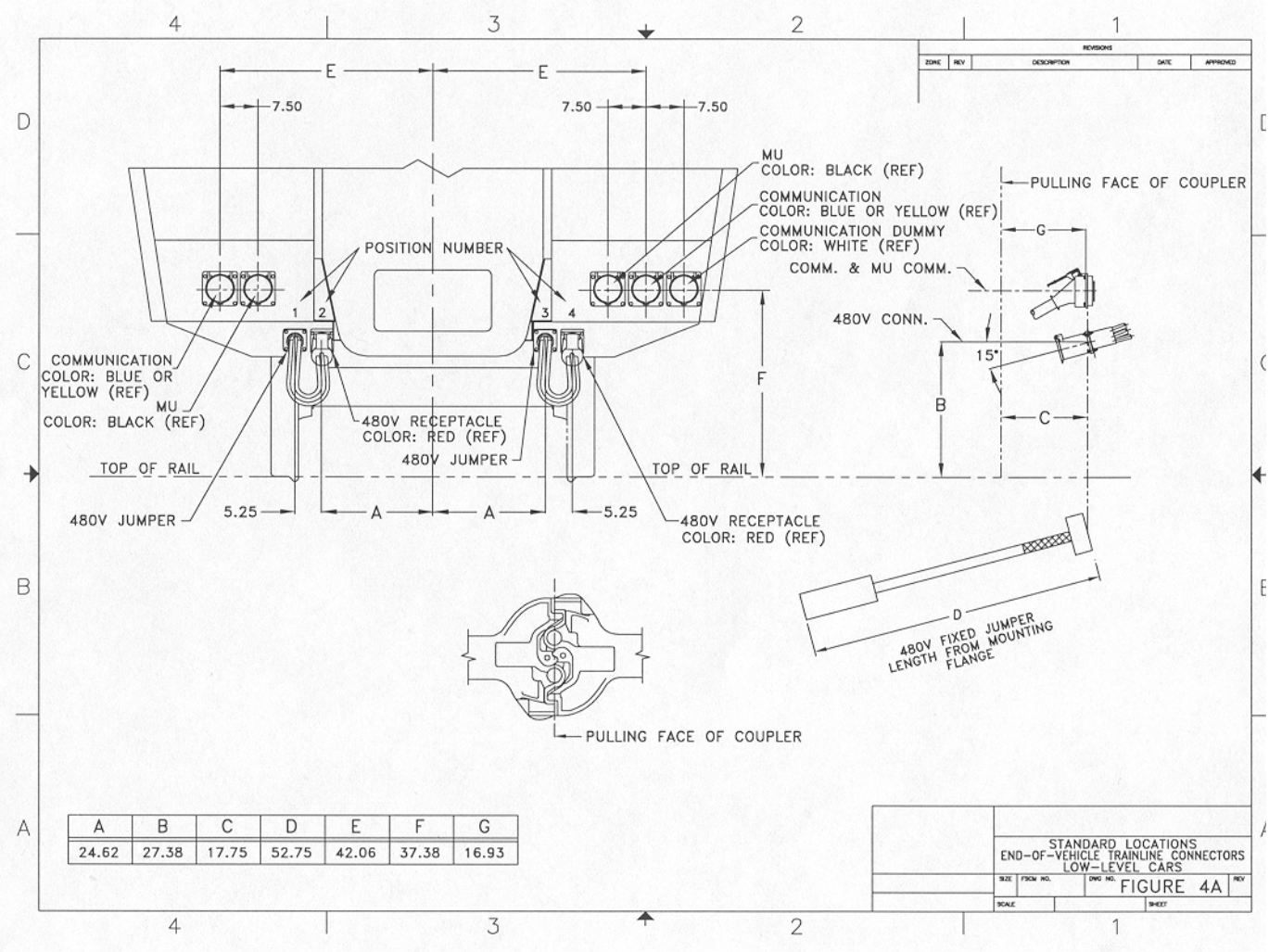
	A	B	C	D	E	F	G	H	J	K	L
OPTION 1	29.25	64.46	19.19	37.50	32.01	18.75	26.54	29.25	50.28	21.56	7.50
OPTION 2	39.00	53.00	25.50	38.63	33.25	33.25	21.75	19.12	40.75	25.50	7.12

Figure 3B Standard Locations: End of Vehicle Trainline Connectors – Locomotive B-end



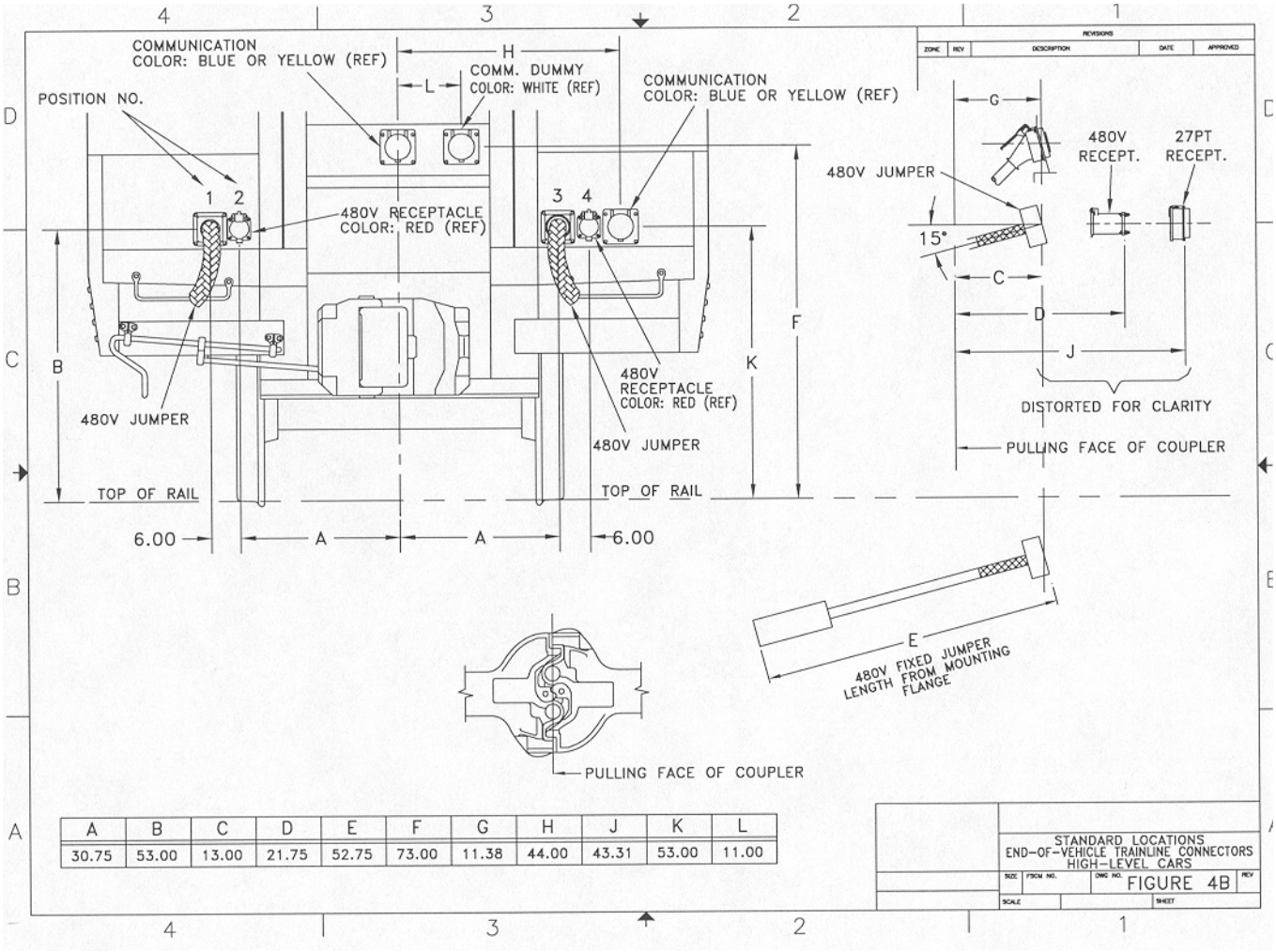
	A	B	C	D	E	F	G	H	J	K
OPTION 1	43.00	50.83	35.13	35.08	33.04	31.63	52.75	29.25	50.50	7.50
OPTION 2	45.82	57.18	18.15	23.00	27.88	25.50	52.75	39.50	50.06	8.00

Figure 4A Standard Locations: End of Vehicle Trainline Connectors Low-Level Car



A	B	C	D	E	F	G
24.62	27.38	17.75	52.75	42.06	37.38	16.93

Figure 4B Standard Locations: End of Vehicle Trainline Connectors - High level car



A	B	C	D	E	F	G	H	J	K	L
30.75	53.00	13.00	21.75	52.75	73.00	11.38	44.00	43.31	53.00	11.00