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Kalmar Group Standard

KGS 50902

Part
Method Standard

Group
Manufacturing Methods

Name
Electrical Specification for Manufacturing Wiring Harnesses & Cables

1 Scope

This is a specification which allows for a variety in material selection yet provides a uniform method of processing to ensure a consistent quality with harness and cable manufacturing. This standard is applicable to all harnesses and cables manufactured for or by Kalmar and for the Terminal Tractor product line.

2 Purpose

This document provides the supplier/manufacturer with the correct procedures to manufacture harnesses and cables to meet the Kalmar Terminal Tractor requirements and specifications

3 Responsibilities

Suppliers/Manufacturers - shall use this specification to manufacture harnesses and cables to conform with Kalmar Terminal Tractor standards.

4 Definitions

N/A

5 Records / references / attachments

SAE J163	Low Tension Wiring and Cable Terminals and Splice Clips
SAE J561	Electrical Terminals - Eyelet and Spade Type
SAE J562	Nonmetallic Loom
SAE J858	Electrical Terminals - Blade Type
SAE J928	Electrical Terminals - Pin and Receptacle Type
SAE J1127	Battery Cable
SAE J1128	Low Tension Primary Cable
SAE J1292	Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring
SAE J1939-11	Physical Layer, 250 Kbps, Twisted Shielded Pair
TMC RP 120A	Wiring Specification
UL NFPA 70E	National Electric Code - Standard for Electrical Safety in the Workplace

6 Procedure Description - General Specifications

6.1 Dimensions

- All dimensions are shown in millimeters (mm), unless otherwise specified.
- Harness termination breakout dimensions are from end of covered or tied portion (shown as solid lines) to end of terminal, mating face of connector, or center of ring and spade terminals.

Table 1- Non-Insulated Section Guide

Connector Width	Minimum Insulation Distance to back of connector
Up to 37.5 mm (1.5 in)	50 mm (2 in)
37.6 to 62.5 mm (1.6 to 2.5 in)	75 mm (3 in)
62.6 to 99.5 mm (2.6 to 3.9 in)	100 mm (4 in)
Over 100 mm (4 in)	125 mm (5 in)

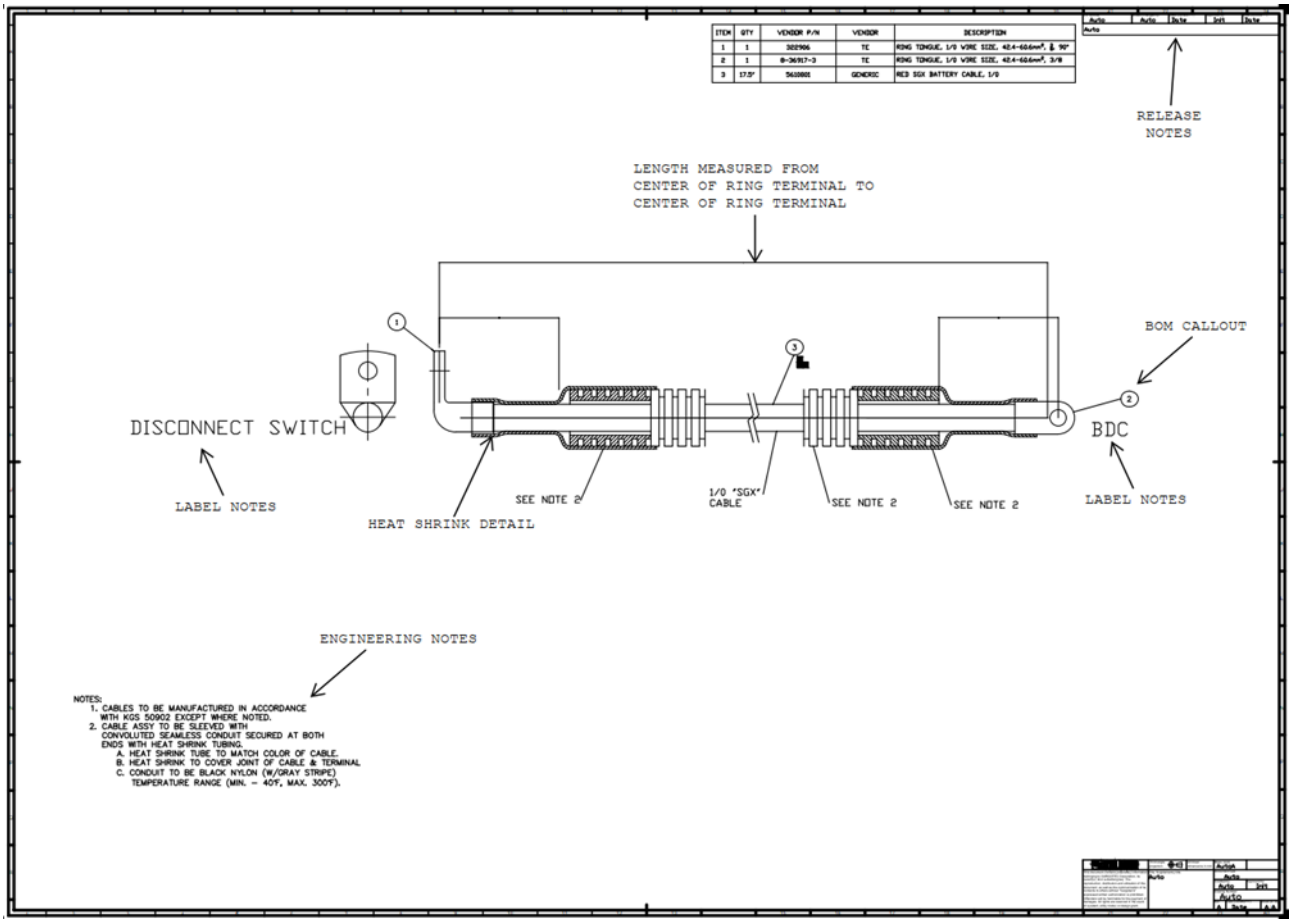

Figure 1 - Basic Cable Drawing Layout

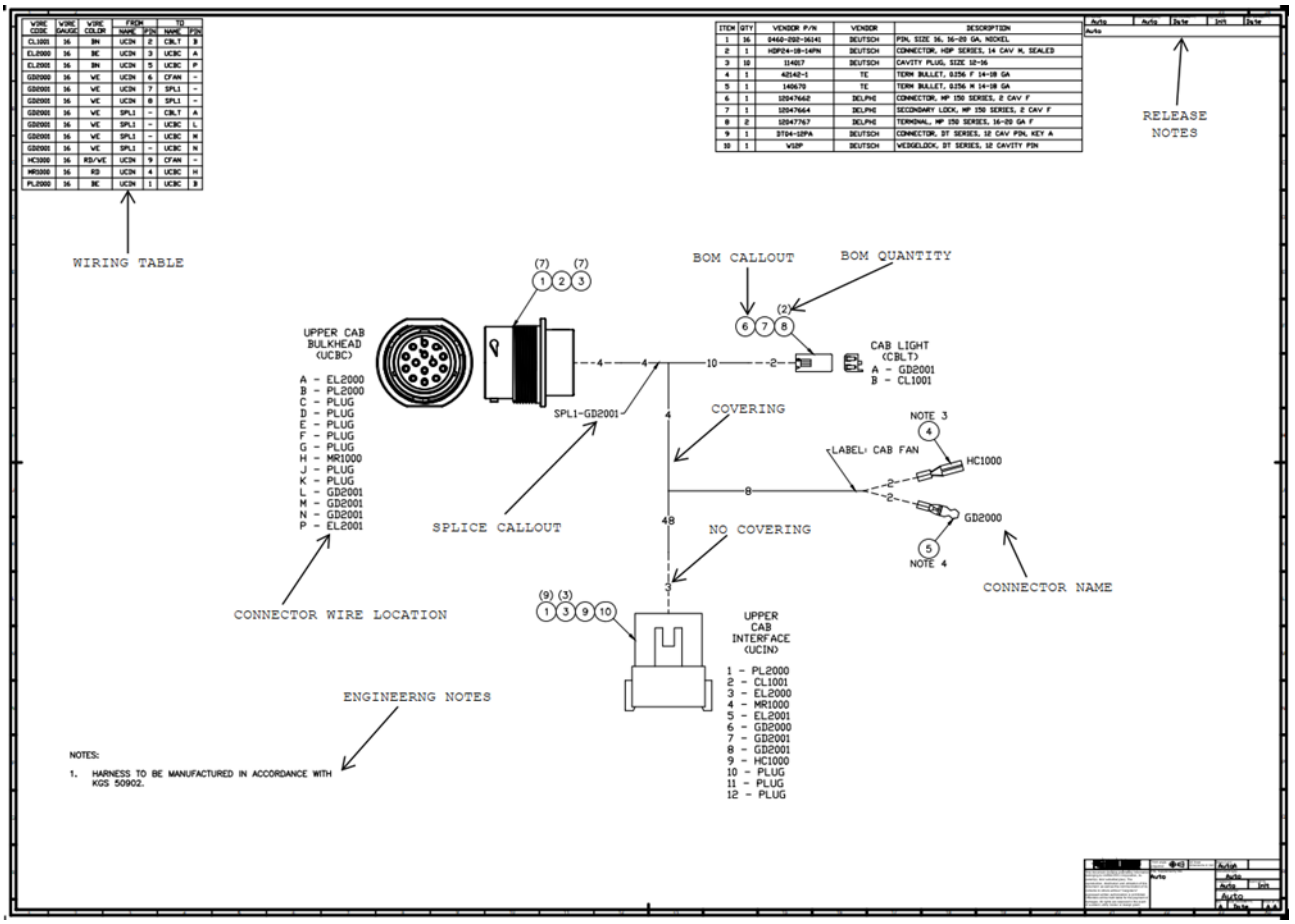

Figure 2 - Basic Harness Drawing Layout

Dimension tolerances for assemblies are given in Table 2:

Table 2 - Dimensions and Tolerances

WIRE HARNESS TOLERANCE CHART (mm)								
Length	Single Lead (see note 2)		Dimension Along Trunk Between Breakouts		Breakouts Extending From Assembly		Overall Length of Assembly (see note 1)	
-	+	-	+	-	+	-	+	-
0-150	12	12	25.4	25.4	25.4	12	25.4	25.4
150-610	25.4	12	25.4	25.4	25.4	12	25.4	25.4
610-2540	25.4	12	25.4	25.4	25.4	12	50.8	50.8
2540-5080	25.4	12	38	38	25.4	12	50.8	50.8
>5080	25.4	12	50.8	50.8	25.4	12	50.8	50.8
NOTE 1: Overall length is defined as the sum of all segments between any two endpoints NOTE 2: When a harness consists of only single leads, utilize the single lead tolerance.								

6.2 Terminals and Connectors

- Eyelet and spade type terminals shall conform to SAE J561.
- Pin and receptacle (bullet) type terminals shall conform to SAE J928. The receptacle terminal shall be detented.
- Male blade type terminals shall conform to SAE J858A,Type 1A or 1B. Female receptacles shall be capable of properly mating with appropriate size and type male terminals.

- When hard-shell connectors are employed, terminals used shall be those recommended by the connector manufacturer. Machined terminals are the preferred style and stamp and formed terminals are an acceptable substitute.
- All terminals not within connectors are to remain uninsulated, unless bullet style connections or otherwise noted on harness drawings.
- Bullet style connectors should be covered with heat shrink tubing. Tubing to extend onto the attached cable 6 mm minimum. Reference section 6.6 relating to heat shrink tubing. Pre-insulated terminals are not to be used.

6.3 Crimps

- All terminals shall be crimped to the conductor. Tensile strength shall be as given in Table 3. All crimps shall be in compliance with SAE J163. The application of two or more conductors in a single terminal shall not be practiced.
- Soldering shall not be used for any connections.
- Crimps shall conform to the terminal manufacturer's recommended practice for tooling and final crimp geometry. Hand crimping must be approved by Kalmar engineering with an approved manufacturing process.
- Pull force values should follow the manufacturer's specifications. If manufacturers specifications are not available, the UL values should be met. See Table 3.

Table 3 - Pull Force Values

Test Values for Pull Force Test			
UL486A			
Size of Conductor		Pullout Force*	
AWG	mm^2	Lbf	N
30	0.05	1.5	6.7
28	0.08	2	8.9
26	0.13	3	13.4
24	0.20	5	22.3
22	0.324	8	35.6
20	0.519	13	57.9
18	0.823	20	89.0
16	1.31	30	133.5
14	2.08	50	222.6
12	3.31	70	311.5
10	5.261	80	356.0
8	8.367	90	400.5

6.4 Splices

- Splices shall be situated in the main body of the harness and if not located dimensionally on the drawing, are to be placed so as to require the minimum total amount of wire possible consistent with maintaining a balanced splice.
- Splices shall not be located less than 2" from any breakout nor less than 2" from adjacent splices except when required for J1939 compliance.
- Splices for J1939 CAN must conform to SAE J1939-11 specifications when applicable.
- Splices shall be ultrasonic welded as the preferred method . If ultrasonic welding cannot be used, the splice may be crimped per manufacturers' specification. All splices must be covered in a heat shrink tubing sleeve. Tubing to extend past bare wire by a minimum of 1/4". Soldering of splices is prohibited.
- Unauthorized splices are prohibited.

- Splices for fusible links are to be of the parallel design or ultrasonic welded.

6.5 Harness Covering

- Sections of the harness shown in solid lines depict where harness covering is to be used. Sections of the harness that are shown with a dotted line depict no harness covering to be used. Reference drawing Figure 1 and Figure 2
- Harness covering shall be high temperature, split side, convoluted tubing. The harness manufacturer must use the smallest tube size to accommodate the maximum number of wires in the bundle. Tube diameter shall be of appropriate size for the number of wires that meets an 80% fill rate. Tubing must meet SAE J562 - Non-Metallic Loom and have a minimum continuous operating temperature rating of 248°F, and a minimum distortion temperature of 356°F.
    - Reference:
      Hellerman Tyton Black w/Gray stripe round convoluted conduit slit (CTN380STD)
- When specified, braid type harness covering must be Hytrel Coated Nylon Braid. Braid should have a minimum Continuous Operating Temperature of 300°F and a Min. Short Term Exposure rating of 325°F.
    - Reference:
      Engineered Yarns Inc. EY-1877 or equivalent.
- When specified, braided sleeve type harness covering should have a maximum operating temperature of 257°F and a melt temperature of 464°F.
    - Reference:
      Cary Industries CXpando FR or equivalent.
- Wire ties are to be installed every 4" (100mm) on harnesses and sections of harnesses that have two or more wires that are not covered by convolute tubing or braid.
- For harnesses covered by convolute tubing:
    - Where wires emerge from the convolute tubing, the wires are to be taped together with a minimum of three wraps of vinyl tape and then taped to the convolute tubing to prevent relative movement between the two. As an alternative construction, heat shrink tubing may be used as a replacement for vinyl tape.
    - Split convoluted tubing must be taped every 4 inches with a minimum of two wraps of PVC tape to avoid tube separating.

6.6 Heat Shrink Tubing

- Heat shrink tubing shall be fire retardant and must meet a UL94-V0 rating, may be flexible construction or semi-rigid, polyolefin tube with an integral internal layer of thermoplastic adhesive. Adhesive shall not interfere with normal insertion of the mating terminal; shrink tubing with the above properties, but without adhesive may be substituted in these cases. Shrink tubing will provide complete coverage of the mating terminals without interfering with proper mating.
    - Reference:
      Raychem SCT Series
- Shrink tube with the same or better characteristics and similar physical performance may be substituted. Glue content must remain unchanged or increased from the product outlined.
- Shrink tube should not leave any exposed bare wire when applied to a terminal
- Shrink must not interfere with mating connections when applied.

6.7 Cable (Wire)

6.7.1 Type

All low tension primary cable, 8 through 18 gauge, should be Type GXL per SAE J1128, unless otherwise noted. Type TXL cable is acceptable if terminals and cable seals are resized as required.

All low tension primary cable, 6 through 4/0 gauge, should beType SGX per SAE J1127, unless otherwise noted. Types STX & SXL are acceptable alternatives.

Fusible links are SXL wire only and should only be used for legacy systems and are not allowed for new designs.

All shielded twisted pairs must conform to J1939-11 for CAN. Manufacturers may use the recommended Champlain cable 23-00025 or 23-00033, similar structured cables may be approved in writing by engineering.

6.7.2 Color

Color code is to be in accordance with SAE J1128.

Table 4 - WIRE COLOR

ESN0021	KGS 50902	COLOR
BK	BK	BLACK
GN	GN	GREEN
BN	BN	BROWN
BE	BL	BLUE
GY	GY	GRAY
PK	PK	PINK
RD	RD	RED
TN	TN	TAN
VT	VT	VIOLET
WE	WT	WHITE
OE	OR	ORANGE
YW	YL	YELLOW
-	CL	CLEAR

Stripe code application of two longitudinal stripes 180 degrees apart is preferred; one spiral stripe is acceptable.

Fusible links to be white unless otherwise noted on drawing.

6.7.3 Wire Numbers

Wire numbers are to be hot stamped every 4" along the entire length of wire, except for fusible links.The first label must be as close to the termination and legible. An acceptable alternative is inkjet printing. Ink color to provide adequate contrast with wire color. Wire destination characters, if applicable, may also be included at the harness manufacturer's option.

Table 5 - Wire Numbers Codes (2003-UP)

WIRE CODE	WIRE GAUGE	WIRE COLOR	FROM		TO	
			NAME	PIN	NAME	PIN
CODE	GA	COLOR	FROM	PIN	TO	PIN

Table Definitions

1. Code - Engineering to use WireCodeE6.xls
2. To and From - wire termination point
3. Pin - Connector Cavity Position

Table 6 - Wire Numbers Codes (Pre-2003)

WIRE DESTINATION	WIRE GA	WIRE COLOR	WIRE DESCRIPTION
111 A-B	GA	COLOR	DESCRIPTION ******
1. A- Wire number (2-4 numbers) B- Wire destination (Alpha Characters) 2. Wire gauge 3. Wire Color 4. Description			

6.7.4 Fusible links

Fusible links are to have "FUSELINKn" printed on the entire length of the link with a single character space between. The wire gauge is to be printed in place of the "n".

6.8 Electrical Check

Finished harnesses are to be 100% tested per PPAP standards to ensure proper orientation and continuity of all circuits.

6.9 Identification / Labels

- Kalmar part number.
- Engineering Change (Revision) Level
- Date of Manufacture
- Vendor Identification
- The above is to be imprinted on adhesive backed tape and attached at the head of the assembly on the main body or connector.

6.10 Deviations

Deviations are not permitted unless authorized in writing by Kalmar. Kalmar allows the use of interchangeable parts that do not require a deviation if listed in this document. See 6.11

6.11 Connector Cross Reference

The following drawing part numbers provide an approved list of connectors that may be interchanged with one another without receiving an approved deviation.

Kalmar Drawing Numbers:

- CTT00027770 – DT-AT CONNECTOR CROSS REFERENCE
- CTT00027771 – DTM-ATM CONNECTOR CROSS REFERENCE
- CTT00027772 – DTP-ATP CONNECTOR CROSS REFERENCE
- CTT00027773 – HDP-AHDP SERIES 18 CONNECTOR CROSS REFERENCE
- CTT00027774 – HDP-AHDP SERIES 24 CONNECTOR CROSS REFERENCE

6.12 Appendix

**Table 7 - Wire Number American Wire Gauge (AWG)
To Metric Equivalents**

AWG	mm2	AWG	mm2	AWG	mm2	AWG	mm2
30	0.05	18	0.75	6	16	4/0	120
28	0.08	17	1.0	4	25	300MCM	150
26	0.14	16	1.5	2	35	350MCM	185
24	0.25	14	2.5	1	50	500MCM	240
22	0.34	12	4.0	1/0	55	600MCM	300
21	0.38	10	6.0	2/0	70	750MCM	400
20	0.50	8	10	3/0	95	1000MCM	500