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TMM P001

COPPER CABLE TERMINATION

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Engineering Manual

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Summary of change	Section

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1 Introduction

1.1 Scope

This publication sets out the procedures for the use of the Krone L.S.A. Plus Terminating System for the termination of copper telecommunications cables within the RailCorp Communications & Control Systems (C&CS) Division telecommunications network.

The requirements of this procedure are in addition to those of the Australian Communications and Media Authority (ACMA) as detailed in the Australian Communications Industry Forum (ACIF) & the Communications Alliance Limited documents, they do not replace them. If there is a conflict between this standard and the ACMA requirements then the ACMA requirements shall be adhered to and the RailCorp C&CS, Telecommunications Network Manager shall be notified immediately.

1.2 Safety

This document does not deal with the hazards of working on or about the track, in confined spaces or other like hazards. Nor does it deal with the precautions that should be taken because of the potential of remote electrical faults, electro-magnetic induction, earth potential rise or surges produced by lightning.

Supervisors and technicians should make themselves aware of the hazards and potential hazards that are associated with each work location and take the precautions necessary to minimize these hazards.

Reference should be made to the relevant RailCorp Safety Management System Documents.

2 Reference documents

2.1 Australian Standards

HB 243 - Communications cabling manual Module 1 Australian regulatory arrangements

HB 29 - Communications cabling manual Module 2 Communications cabling handbook

AS/CA S008 - Requirements for Customer cabling products

AS/ACIF S009 - Installation Requirements for Customer Cabling (Wiring Rules)

AS/NZS 3080 - Telecommunications installations-Generic cabling for commercial premises

AS 3084 - Telecommunications installations-Telecommunications pathways and spaces for commercial buildings

AS/NZS 3085.1 - Telecommunications installations-Administration of communications cabling systems

AS/NZS 3835.1 - Earth Potential Rise - Protection of telecommunications network users, personnel and plant Part 1: Code of practice

AS/NZS 3835.2 - Earth Potential Rise - Protection of telecommunications network users, personnel and plant Part 2: Application guide

AS/NZS ISO/IEC 24702 - Telecommunications installations – Generic cabling – Industrial premises

AS/NZS IEC 61935.1 - Testing of balanced communication cabling in accordance with ISO/IEC 11801 Part 1: Installed cabling

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AS/NZS 3000 - Electrical installations (known as the Australian/New Zealand Wiring Rules)

CJC 4 - Coordination of power & telecommunications – Manual for the establishment of safe work practices & the minimization of operational interference between power systems & paired cable telecommunications systems.

CJC 5 - Coordination of power & telecommunications – Low frequency induction (LFI) Code of practice for the mitigation of hazardous voltages induced into telecommunications lines

2.2 RailCorp Standards

ESM 106 Telecommunications for Sub-stations and Section Huts

ESM 109 Communications Earthing and Surge Suppression Standard

3 Terms and definitions

ACIF Australian Communications Industry Forum (now Communications Alliance Ltd)

ACMA Australian Communications & Media Authority

C&CS Communications & Control Systems (RailCorp)

DC Direct Current

EPR Earth Potential Rise

FDM Frequency Division Multiplexing

HV High Voltage

ISDN Integrated Services Digital Network

MDF Main Distribution Frame

NTD Network Termination Device

PCM Pulse Code Modulation (Obsolete technology currently being phased out)

PVC Polyvinyl chloride

KRONE: RailCorp preferred propriety brand of structured cabling system

service cable a cable connecting a track side cabinet or MDF to a location that uses the services. eg. Station MDF.

Track side cabinet is the breaking and termination point for communications cables where the main trunk cables are, or in the future can be, loaded, connected to PCM. repeaters and/or connected to service cables.

Distributor a collection of components used to terminate cables which provide a point for line cross-connection.

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4 Termination

4.1 General

RailCorp uses the Krone L.S.A. Plus Terminating System for the termination of copper telecommunications cables.

Cables are terminated in the slots on the top of the Krone modules (cable side) while jumper wires are to be terminated in the bottom slots of the modules (numbered slots).

Pairs are to be terminated with the correct polarity, that is wire 1 (A leg) in the slot to the left of the number and wire 2 (B leg) in the slot to the right of the number. (See Appendix for cable colour codes)

4.2 Stainless Steel Jumperable Frames and Profil Frames

The method adopted by RailCorp of mounting Krone modules is the stainless steel back mount frame. These have more reliable earthing for arrestors and the modules cannot be easily moved up and down the frame. Record keeping is therefore a much simpler task. Profil frames shall not be used.

4.3 Termination of 0.64mm & 0.5mm Conductors on Disconnection Modules

The preferred method of terminating 0.5mm and 0.64mm cable is described in the following.

Disconnection Modules (Krone part No. 6468 1 121-02) shall be used to terminate cables with 0.64 and 0.5mm diameter conductors.

The cable is firstly divided into 10 pair units. Each unit then is passing though the loop at the back of the respective module and the unit is then securely tied.

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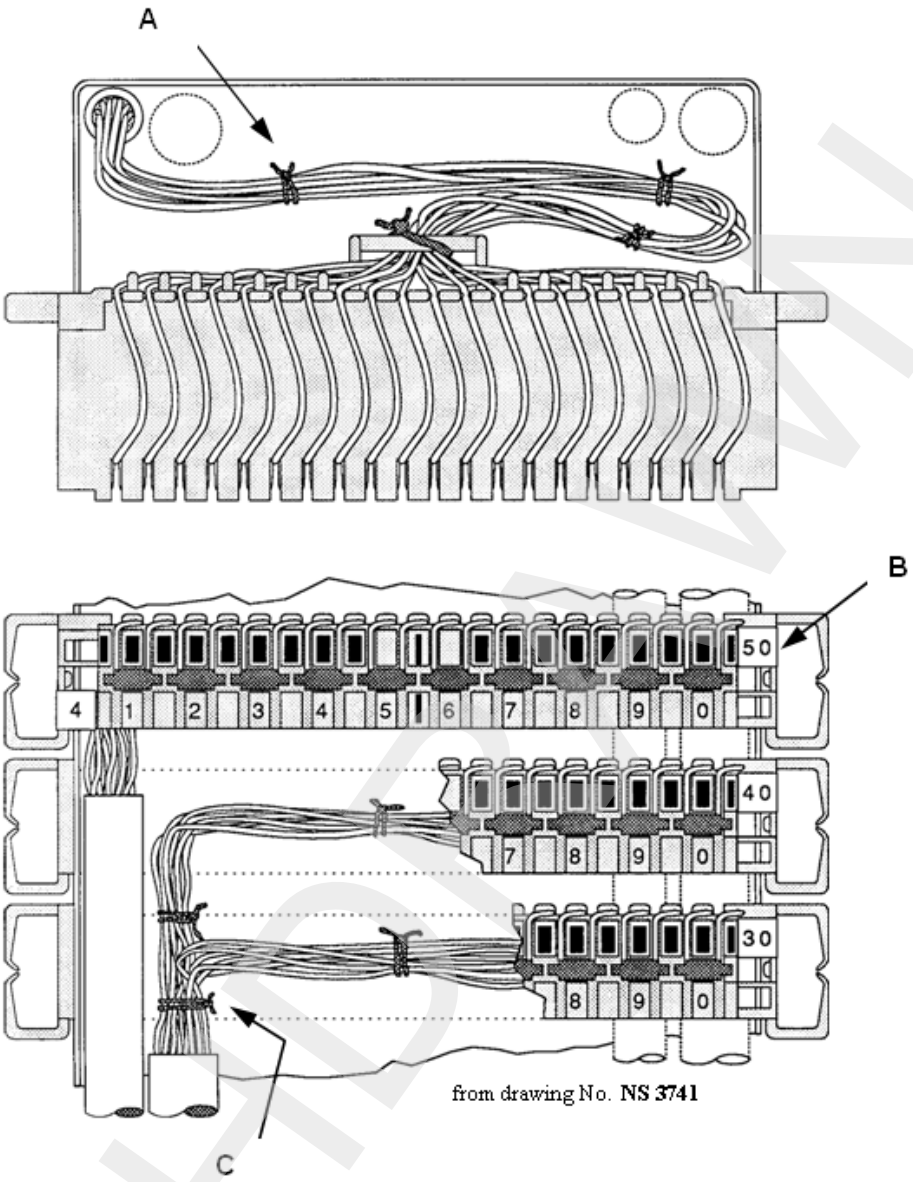

Where

A A gooseneck of approximately 140mm length (the same length as the handle of the Krone insertion tool) shall be laid horizontally behind each associated module. The gooseneck should be pulled forward to leave room for future cables

Each conductor shall be located in its own restraint prior to insertion into the contacts (punch down).

B Module Numbering Plugs - the “4” in this example, represents the 4 in 41 (the first pair in the 10 pair unit) and 4 in 42 etc. The 50 represents the last pair in the unit. These numbers correspond to the pair position numbers in the frame. As modules are grouped together in tens modules, only the tens of the pair positions are shown and not the hundreds. Also see numbering in section 10

C The cable trunk is laced with branches of 10 pairs for each module (small cable ties shall be used). All cables shall enter the frame from one direction only but it is preferable that they enter from the bottom.

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If a single back mount frame accommodates both incoming and local cables then the incoming cables should be laid in the left hand rear corner of the frame and local in the right rear corner of the frame.

When using 11 and 27 way back mounts the cables shall be anchored at the respective cable tie provisions in the plastic end plate.

4.4 Termination of 0.9mm Conductors

Interface Modules (Krone part No. 6468 2 050-10) and the S Connection Tool (Krone part No. 6417 2 055-01) shall be used to terminate conductors of 0.9mm diameter. The cable shall be divided into ten pair units, with each unit passing through the loop in the back of the module. Then the unit shall be securely cable tied or laced to this loop. Each conductor shall be located in its restraint prior to its insertion into the termination slot. It is recommended that the conductors be located in the restraints working out from the centre, ie. locating pairs 6 through to 10 first, and then pairs 5 through to 1.

A goose-neck of approximately 140mm shall be left in each unit and shall be arranged as neatly as practical behind the associated module. Cable ties should not be used to tie up the unit goose-neck on 0.9mm conductors as this makes rearrangement difficult. However a cable tie will be used to tie off each unit at the back of its module.

4.5 Termination of 1.27mm Conductors

Where cables with 1.27mm diameter conductors are to be terminated on Krone L.S.A. equipment, then the cable shall be jointed first to a cable with conductors of 0.9mm diameter. Hence this 0.9mm cable shall be terminated as set out in section 4.4 above.

The joint should not be more than 5 metres route length from the point of termination. This joint shall also be used for straightening of the pairs as set out in section 5 below.

4.6 Alternative Termination of 1.27mm Conductors

It is permissible to use the 20 position LSA-PLUS to screw terminal module to terminate 1.27mm conductors module (Part No. 6467 1 007-01). This is particularly useful for cables with small pair counts. It is important to note that the jumper wire is to be terminated on the top of these particular modules as the bottom is unavailable for use.

5 Balance Cable – Transposition and Pair Integrity

Some older telecommunications cables have been balanced. This means that the pairs of a cable are transposed within each unit, reducing the capacitive unbalance to ground and thus decreasing the amount of noise induced into the cable.

Before the cable can be terminated, it must be "straightened out" so that pair integrity is maintained. That is, if pair 1 was jointed to pair 7 and Reversed in the transposition joint, then at the "straightening-out joint" pair 7 shall be connected to the pair colour coded as pair 1 and Reversed. In this way Pair 1 wire 1 of a particular cable terminated in one location, shall be electrically connected to Pair 1 wire 1 of that cable in the next location. The same applies for the polarity and the integrity of all other pairs. (Note that to maintain pair integrity, continuity of the pairs must also be maintained).

To achieve this a "straightening-out joint" shall be installed not more than 5 metres from the cabinet or cable chamber, where the conductors shall be transposed to their original colour scheme.

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An unscreened (unarmoured) cable may be used provided that the earth connection cable is tied to the associated communication cable with cable ties at a spacing not exceeding 500mm.

It is preferred that a "non jelly filled" cable be used if this section of cable.

6 Labelling of Cables

Each cable terminated shall be labelled with a 15mm, a 22mm or a hinged label holder. The label shall clearly describe the cable, the destination and the 2ATX identification code.

For example: 30pr/0.64 2ATX00123

to Rail Travel Centre - Parramatta

or: 100pr/0.9 2ATX00108

to Lidcombe App. room

This label holder shall be located immediately above or, in the case of a hinged label holder, over the front of the top module for each cable.

As a hinged label holder uses the same mount as the module numbering plugs where hinged label holder are used they shall also show the pair position number.

For example:

	30pr/0.9 - Signals Loc 38.4B	
141	**2ATX00451**	**150**

7 Jumper Wire

Connections between terminated cable pairs, shall be made with 0.5mm PVC insulated twisted pair (jumper wire). The jumper wire used shall be manufactured in accordance with AS/ACIF S008.

7.1 Installation of Jumper Wire

The jumper wire is to be rolled off the drum and shall not be coiled off the side of the drum, as this produces coils in the jumpers so that the jumpers will not sit flat.

Only jumper wire is to be used to make connection in the frame.

7.2 Colour Code.

The colour code for jumper wire shall be as follows:

Standard Jumper	**Red / White** for all non-priority lines.	
	RailCorp C&CS Inventory Stock Code. 139 8833	
	Colour code:- White:	Wire 1 (A leg),
	Red:	Wire 2 (B leg)

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Priority Jumper	**Blue / Yellow** for priority lines such as Train Control Operations Control (formerly Traffic Trouble) Pilots (for Electrical branch remote control) Clock pulses, Modems, Alarms, and other priority lines RailCorp C&CS Inventory Stock Code. 139 8841 Colour code:- Yellow: Wire 1 (A leg), Blue: Wire 2 (B leg)
Signalling Telemetry Jumper	Blue / Green for Signalling telemetry lines only RailCorp C&CS Inventory Stock Code. 153 7851 Colour code:- Green: Wire 1 (A leg), Blue: Wire 2 (B leg) **Purple / Brown** for Exchange E1 lines only Non Stock Item Colour code:- Purple: Wire 1 (A leg), Brown: Wire 2 (B leg)

7.3 Jumpers on Krone Modules

Jumpers terminated in slots 1 to 5 shall leave the module from the left side jumper wire entry guide and jumpers in slots 6 to 10 shall leave to the right. Install the jumpers with sufficient slack (20-40mm) to allow for tracing.

8 Marking Caps

Coloured marking caps are used to help in the identification of priority jumper wires and circuits.

Red Critical and high- circuits

Green Other important circuits that require identification

Figure 1

The coloured marking caps are normally located on the jumper side of the Krone module.

High-risk circuits have marking caps on both the jumper and cable side of the Krone module. If an arrestor magazine is not fitted to the module then Dummy Plugs are used block access to the disconnect contacts.

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9 Layout of the Distribution Frame

All distributors including MDFs shall be arranged in an orderly way. The ease of use, for both the present and the future shall be considered in determining the layout of the distributor. As each site is different it may require a unique layout. At all sites the following guide lines shall be adhered to.

9.1 Grouping of Terminations

Equipment, internal and external cables shall be separately grouped. Within these groups the various equipment and cables shall be laid out into types, for example, Alarms should be grouped together separately from exchange equipment. Cables should be laid out in geographical groups where possible. (eg. up cables, down cable and local cables.)

If an external carrier's cable is to be terminated on a single frame, then it shall occupy the lowest module(s) in the frame. If multiple frames are used then they shall occupy the 1st frame(s) from the left hand side.

9.2 Recommended Size Limits

Limits on size and type of frame within an installation will depend on the number of pairs to be terminated and the space available for the mounting of the frames. It is recommended that a minimum of 30% excess capacity be provided in the frame for future expansion. Frame installations should allow for a 100% increase in the number of verticals.

The following table gives the recommended size and type of frame to be used:

Frame size and type	Use
20 pair termination box	5, 10 or 20 pair cables
11 way frame(s)	More than 20 pair incoming (from the exchange side)
27 way frames	Four or more 11 way frames would be required horizontally or if two would be used vertically
Wall mounted frames	More than four 27 way frames would be required
Island frames (If space available)	More than 10 verticals in a wall mounted frame would be required

Provision for the future is very important. Plan for it. Expansion will almost certainly happen.

10 Cable support

Cable shall be protected and supported within the apparatus room by conduits, ducting, wall mounted galvanized steel mesh, cable tray, ladder racking or other suitable means.

Whatever system is used all sharp edges shall be removed or protected in such a manner that persons and cable are not exposed to the potential of damage or injury. The cable supporting system shall take into consideration the minimum bending radius of the cables that shall be run. Provision for the future is very important, it is recommended that 50% excess capacity be provided for future expansion.

10.1 Earthing of Cable Support

All metallic structures in the cable supporting system shall be earthed as per the requirements of ESM 109 Clause 11.9

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10.2 Conduit

Conduits shall be suitably sized so as to contain the required cables without cramming. Cramming makes installation difficult and maintenance impossible

Supports for the conduit shall be spaced not greater than 1 metre apart

Conduits shall have all burrs and sharp edges removed from their internal surfaces.

10.3 Ducting

The method of supporting the ducting shall be in accordance with the manufacturer's recommendations.

Ducts shall have all burrs and sharp edges removed from their internal surfaces.

10.4 Wire Mesh Support

At times it is an advantage to support cable by cable tying it to a wire mesh mounted vertically on a wall. Where this type of support is used the mesh shall be made of galvanized steel rod not less than 4mm in diameter and shall have grid spacing of between 50 and 75mm There shall be a minimum of 25mm stand out from the wall. This stand out is best achieved by either vertical or horizontal lengths of Unistrut at spacing of not more than 1 metre.

Cables are to be secured to the mesh cable by ties. The distance between cable ties shall not exceed 200mm for a horizontal run and 500mm for vertical runs.

10.5 Cable Trays and Ladder Rack

The manufacturer's installation instructions shall be adhered to and in particular the method of supporting the tray, distance between the supports and the load bearing capability of the tray.

Bolts and sharp objects shall not protrude through the cable supporting surface of the tray.

To prevent rust on cable trays & ladders that have been cut, any cut surface must be painted with cold galvanizing paint.

11 Numbering

11.1 Numerical Component

To identify the pairs within a vertical of a distribution frame, pairs shall be numbered. Numbering shall commence at the bottom module position of each vertical (Not accessory positions), and pairs shall be numbered from left to right as pairs 1 to 10. The pairs in the next module position up are numbered 11 - 20. The numbering continues up the frame in like manner even if module positions are presently vacant as these positions may be used at a future date. However accessory positions are not to be numbered nor shall a cable be terminated in any accessory position. This position shall be reserved for accessories such as label holders, test modules, earth modules, etc.

In the numbering scheme for all frames (other than the 31 way back mount used in the Krone cabinet), each 11th position is reserved for accessories. See Table 1.

See Table 2. for 4 wire E and M termination scheme & G703 Krone Termination.

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The numbering scheme for the 31 way back mount used in the Krone cabinet differs from other frames. In the 31 way back mount the 1st module position is reserved for accessories and the other 30 positions are used for general terminations. See Table 3.

11.2 Wall Mounted Frames - Alphabetical Designation of Verticals

Verticals of a wall mounted frame are designated alphabetically starting with the left most vertical as vertical A, next to that B and so on along the frame.

The letters "I" and "O" shall not be used in the alphabetical designation as they can be confused with the numbers "1" and "0".

Particular pair positions in a distribution frame shall be distinguished alpha-numerically

eg. pair 102 in vertical A shall be called "A-102".

11.3 Track Side Cabinets - Alphabetical Designation of Verticals

In a track side cabinet verticals are designated alphabetically from left to right. The frames in the front are designated as A, B, C, D, and in the back as E, F, G, H. Unused vertical positions shall also be designated with a letter.

For example, if in a cabinet the first two positions are taken up by a P.C.M. repeater and the next two by back mount frames, then these two verticals shall be designated as verticals "C" & "D".

If two ore more cabinets are side by side then the verticals in the second cabinet shall be designated as verticals J, K, L, M, N, P, Q and R.

11.4 Island Distribution Frame - Identification of Verticals

To identify the verticals of an island MDF the in-coming cable side verticals (generally 5x11 way) shall be designated alphabetically and shall read from left to right when viewed from the front.

The distribution side verticals shall be designated alpha-numerically and shall read from right to left when viewed from the front. The first part of this code shall be the letter "V" followed a number that shall increment

eg. pair 002 in vertical 7 shall be called "V7-002".

11.5 Extension of Frames

If an MDF or distributor is extended to the left past the vertical designated as "A" then the vertical immediately to the left shall be designated as " Z Z ". The next left as " Z Y ", then " Z X " and so on.

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Module Position	Module Plug Number	Pair Number			
55	Accessory position	- - - - - - - - - -			55 Way frames
54	9	491	-	500	
53	8	481	-	490	
52	7	471	-	480	
51	6	461	-	470	
50	5	451	-	460	
49	4	441	-	450	
48	3	431	-	440	
47	2	421	-	430	
46	1	411	-	420	
45	0	401	-	410	
44	Accessory position	- - - - - - - - - -			
43	9	391	-	400	
42	8	381	-	390	
41	7	371	-	380	
40	6	361	-	370	
39	5	351	-	360	
38	4	341	-	350	
37	3	331	-	340	
36	2	321	-	330	
35	1	311	-	320	
34	0	301	-	310	
33	Accessory position	- - - - - - - - - -			
32	9	291	-	300	
31	8	281	-	290	
30	7	271	-	280	
29	6	261	-	270	
28	5	251	-	260	
27	4	241	-	250	27 Way frames
26	3	231	-	240	
25	2	221	-	230	
24	1	211	-	220	
23	0	201	-	210	
22	Accessory position	- - - - - - - - - -			
21	9	191	-	200	
20	8	181	-	190	
19	7	171	-	180	
18	6	161	-	170	
17	5	151	-	160	
16	4	141	-	150	
15	3	131	-	140	
14	2	121	-	130	
13	1	111	-	120	
12	0	101	-	110	
11	Accessory position	- - - - - - - - - -			11 Way frames
10	9	91	-	100	
9	8	81	-	90	
8	7	71	-	80	
7	6	61	-	70	
6	5	51	-	60	
5	4	41	-	50	
4	3	31	-	40	
3	2	21	-	30	
2	1	11	-	20	
1	0	1	-	10	

Table 1 - Module Numbering System for Distributors

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										100
										90
Tx	Rx	ME	Tx	Rx	ME	Tx	Rx	ME	ME 2	80
Tx	Rx	ME	Tx	Rx	ME	Tx	Rx	ME	ME 2	70
Tx	Rx	ME	Tx	Rx	ME	Tx	Rx	ME	ME 2	60
Tx	Rx	ME	Tx	Rx	ME	Tx	Rx	ME	ME 2	50
Tx	Rx	ME	Tx	Rx	ME	Tx	Rx	ME	ME 2	40
Tx	Rx	ME	Tx	Rx	ME	Tx	Rx	ME	ME 2	30
Tx	Rx	ME	Tx	Rx	ME	Tx	Rx	ME	ME 2	20
Tx	Rx	ME	Tx	Rx	ME	Tx	Rx	ME	ME 2	10
1	2	3	4	5	6	7	8	9	10	Pair No.

3rd 4W Card
Pairs 54 - 80

2nd 4W Card
Pairs 27 - 53

1st 4W Card
Pairs 1 - 26

Channel 1 Channel 2 Channel 3

There are 8 Channels/4W Nokia Cards

Note: Terminate M2 & E2 from every third Channel on the tenth pair of Krone Block.

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Pair 1	Pair 2	Pair 3	Pair 4
Tx Data	Rx Data	Tx Clock	Rx Clock

Table 2 - 4 Wire Nokia Channel Allocations Using the KRONE Termination System

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Module Position	Module Plug Number	Pair Number		
31	9	291	-	300
30	8	281	-	290
29	7	271	-	280
28	6	261	-	270
27	5	251	-	260
26	4	241	-	250
25	3	231	-	240
24	2	221	-	230
23	1	211	-	220
22	0	201	-	210
21	9	191	-	200
20	8	181	-	190
19	7	171	-	180
18	6	161	-	170
17	5	151	-	160
16	4	141	-	150
15	3	131	-	140
14	2	121	-	130
13	1	111	-	120
12	0	101	-	110
11	9	91	-	100
10	8	81	-	90
9	7	71	-	80
8	6	61	-	70
7	5	51	-	60
6	4	41	-	50
5	3	31	-	40
4	2	21	-	30
3	1	11	-	20
2	0	1	-	10

Accessory position

Table 3 - Module Numbering Sysetms for the 31 Way Back Mount as used in Track Side Cabinet

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12 Records

A record book or card shall be placed in every track side cabinet, MDF and distributor. This record shall be marked clearly, and only in black pencil so that the records can be up dated.

Each occupied position in the distribution frame shall have an entry in the record book. If a pair is at present unused then that pair shall only have the pair position number and the cable pair number marked in. If the pair is in service then the particulars of service (eg. Exchange Equipment Position Number) and the pair jumpered to it shall be recorded.

Note that for each jumper there are two entries in the record book, one for each cable pair connected by the jumper wire.

12.1 Record Book Updates

When a cable pair is found to be faulty then that fault shall be recorded in the cable record. If a service is removed and the cable pair is not going to be used immediately then a neat pencil line should be drawn through the particulars of service.

Any changes to the existing cabling should be reported to the RailCorp C&CS Configuration Manager.

13 Jelly Filled Cable

It is generally required that jelly filled cables be dry tailed (jointed to an unfilled cable) prior to termination in an apparatus room.

If exceptional circumstance exist such that the cable can not be dry tailed, then all the jelly filled cables shall enter a distribution frame from the bottom and the cable shall be cleaned of jelly.

The dry tail should be a polyethylene insulated cable with 0.64mm conductors and the joint should be arranged in a dry location within a cable pit or cabinet.

13.1 Removal of Jelly

If a filled cable is to be terminated then prior to terminating the cable, the cable shall be cleaned of jelly. The removal of the jelly shall not involve the use of solvents, as this may weaken the cellular polyethylene insulation. The jelly shall only be removed by wiping with a clean rag, cotton waste or paper towels, etc.

It is important when cleaning jelly from the cable that the wires are not jumbled. So it is recommended that the unit to be cleaned is separated, and the unit binder tape be unwound, not cut. Then each wire of each pair should be individually cleaned and then re-twisted with its mate before starting on the next. Once the whole unit is cleaned of jelly, the coloured unit binder tapes shall be wrapped around the unit and tied off close to where it enters the sheath to make it distinguishable before starting on the next unit.

14 Track Side Cabinets – General

Track side cabinets are generally installed for the interconnection of service cables to the main cable, such as for the provision of services to stations etc.

Cabinets shall be located in an area which considers the ease of use and safety of staff. In no circumstance shall cabinets be located closer than 3 metres from the track, closer

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than 3 metres to a mast supporting the 1500v overhead wiring or within 15 meters of a 33kVA HV power pole.

Track side cabinets shall not be installed within an Earth Potential Rise Area (see clause 15.2).

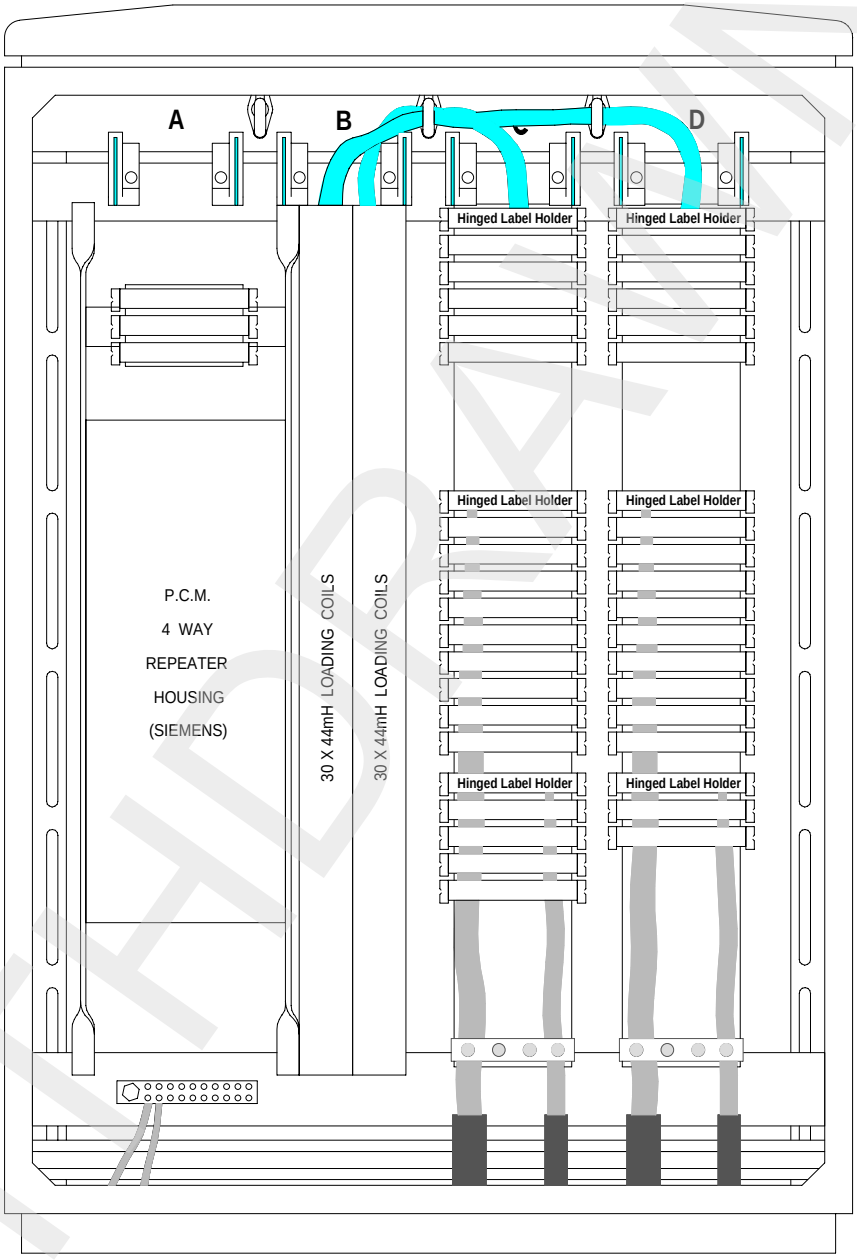

Figure 2 - Cabinet with Loading Coils, P.C.M. Repeater and Service Cables

Note: The illustration shown is of an obsolete type of fibreglass cross connection cabinet.

Stainless steel will be used for new cabinet installations.

14.1 Layout of Track Side Cabinets

The cabinet layout shall be arranged for ease of maintenance, space efficiency, ease of future expansion and economy.

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The arrangement of equipment should where possible, incorporate the principles of left side for the city side cables and right side for the country side. Where the cables are terminated in the same vertical then the principle shall be, city side bottom and country side top.

The design shall incorporate at least two Test Modules in each side of the cabinet (one if only one frame is used) and they shall be mounted in the accessory position of the frame (bottom position). The first module position shall not be used for general termination, but shall be reserved for accessories. See the numbering section and Tables 1 and 2.

The leads of the test module shall be hung over the jumper guides when not in use. They shall not be left on the bottom of the of the cabinet as dust and grit can be pushed into the module contacts causing contact problems.

15 Earthing

15.1 General

All cabling earthing should be in line with the requirements outlined in the RailCorp standard ESM 109 Communications Earthing and Surge Suppression. Technicians and engineers are responsible for making themselves familiar with these requirements and to adhering to them.

15.2 Earth Potential Rise Areas

The risks involved in providing telecommunications facilities to High Voltage Sites are addressed in RailCorp standard ESM 106 Telecommunications for Substations & Section Huts.

Further information with respect to earth potential rise (EPR) hazard zones is given in ESM 109 Communications Earthing and Surge Suppression. Also see AS/NZS 3835.

16 Surge Suppression Devices – Arrestors

16.1 Track Side Cabinet

Within a track side cabinet ALL pairs of each service cable shall be protected using Krone 3 pole arrestor magazines equipped with 230V arrestors inserted in to the service cable termination module. Over voltage protection is generally not required on the main cables.

16.2 Other Locations

At an exchange, apparatus room or cable chamber all pairs of each external cable shall be protected using Krone 3 pole arrestor magazines equipped with 230V arrestors.

16.3 Arresters: Earth Potential Rise Areas

No cable shall be arrested to earth in Earth Potential Rise Areas.

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17 Testing of Cable and Terminations

17.1 Insulation Resistance (external cables only)

The measurement of the insulation resistance shall be taken for each conductor in each cable. The measurement shall be carried out with all conductors other than the one under test connected to the metallic screen and earth. The insulation resistance of the conductor under test shall not be less than 20,000 M ohm km after electrification for one minute at 500 Volts DC.

17.2 Pair Integrity

The installer shall check the integrity of the terminated cable to ensure that the terminations and joints are electrically sound, and if the cable has been balanced, then the installer shall check that the cable has been correctly straightened out after transposition. One of the simplest ways to test both these is by putting a loop on one pair at the distant end and measuring the loop resistance of that pair. This ensures that pair 1 at one end is pair 1 at the other and the joints are sound (see Appendix Table 5 for loop resistances).

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Appendix A Copper Cable Colour Code

Number of Element	QUADS / TRIPLES / PAIRS wire 1	wire 2	wire 3	wire 4
1	White	Blue	Red	Black
2	White	Orange	Red	Black
3	White	Green	Red	Black
4	White	Brown	Red	Black
5	White	Gray	Red	Black
6	White	Blue / White	Red	Black
7	White	Blue / Orange	Red	Black
8	White	Blue / Green	Red	Black
9	White	Blue / Brown	Red	Black
10	White	Blue / Gray	Red	Black
11	White	Orange / White	Red	Black
12	White	Orange / Green	Red	Black
13	White	Orange / Brown	Red	Black
14	White	Orange / Gray	Red	Black
15	White	Green / White	Red	Black
16	White	Green / Brown	Red	Black
17	White	Green / Gray	Red	Black
18	White	Brown / White	Red	Black
19	White	Brown / Gray	Red	Black
20	White	Gray / White	Red	Black

Table 4 - Colour Code for Internal PVC Insulated Cables

Note 1 For cables with more than 20 cables elements, the above colour code shall repeat except that wire 1 in each succeeding group of 20 cable elements shall be the following colour:

Pairs 21 - 40	Yellow
Pairs 41 - 60	Black
Pairs 61 - 80	Violet
Pairs 81 - 100	Red

Note 2 For cables with more than 100 pairs, the colours for the first 100 pairs are repeated for each successive 100.

Note 3 Conductor colours for 6 wire cables are as follows:

Wire 1	White	Wire 4	Black
Wire 2	Blue	Wire 5	Orange
Wire 3	Red	Wire 6	Green

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PAIR Number	COLOUR OF CONDUCTOR INSULATION	
	A-leg (wire 1)	B-leg (wire 2)
1	White	Blue
2	``	Orange
3	``	Green
4	``	Brown
5	``	Grey
6	Red	Blue
7	``	Orange
8	``	Green
9	``	Brown
10	``	Grey

Table 5 - Unit Twin Cable - Conductor Insulation Colour Code

SUB-UNIT No.	SUB-UNIT WHIPPING COLOUR
1	Blue /Blue
2	Orange / Orange
3	Green / Green
4	Brown / Brown
5	Gray / Gray
6	Blue / White
7	Orange / White
8	Green / White
9	Brown / White
10	Gray / White

Table 6 - Sub-Unit Whipping (Binder Tape) Colour Code
Each 10 pair sub-unit has a colour code whipping (Binder Tape)

LAYER	QUAD DESIGNATION	PAIR 1		PAIR 2	
CENTRE	Marker (1st)	Blue	White	Brown	Black
	Even	Yellow	``	``	``
	Odd	Green	``	``	``
	Last (Reference)	Gray	``	``	``
ODD	Marker (1st)	Blue	White	Brown	Black
	Even	Red	``	``	``
	Odd	Violet	``	``	``
	Last (Reference)	Gray	``	``	``
EVEN	Marker (1st)	Blue	White	Brown	Black
	Even	Yellow	``	``	``
	Odd	Green	``	``	``
	Last (Reference)	Gray	``	``	``

Table 7 - Quad Type Cables Colour Code

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Conductor size	Resistance ohms / km.	Loop Resistance ohms / km.
0.4	144	288
0.5	92.2	184.4
0.64	56.3	112.6
0.90	28.0	56.0
1.27	13.9	27.8

Table 8 - Conductor Resistance

Pair No.	Wire 1 / A Leg	Wire 2 / B Leg
1	White / Blue	Blue
2	White / Orange	Orange
3	White / Green	Green
4	White / Brown	Brown

Table 9 - Colour Code for 4pr Category 5 Cables

Pair	Wire 1	Wire 2	Normal use
1	White	Blue	Tx
2	White	Orange	Rx

Table 10 - 2 Pair ISDN Cable

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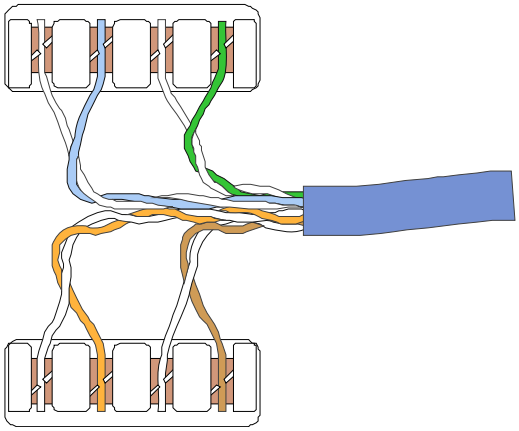
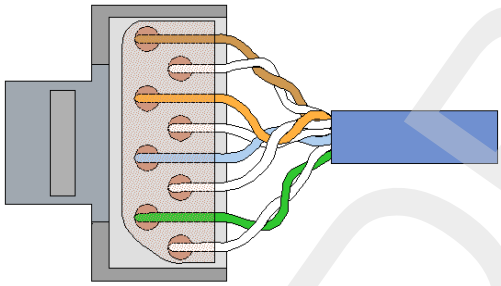
Appendix B Termination of Category 5 and Category 5E cable





For category 5 terminations there are some important requirements:

1. Twists are to be maintained right up to the termination slot.
2. Wires of each pair are to be as near as possible the same length
3. The work must be neat.

Remember that category 5 means that the system will be used in the future for data communication with bit rates up to and over 100 Mbps. Power loss and noise will cause problems in systems where cable is not terminated correctly.

Pin No.	Colour	Pair/Leg	Pair No.
1	White/Green	3/A	Pair 3
2	Green	3/B	
3	White/Orange	2/A	Pair 2
4	Blue	1/B	
5	White/Blue	1/A	Pair 1
6	Orange	2/B	
7	White/Brown	4/A	Pair 4
8	Brown	4/B	

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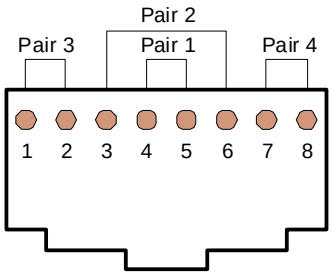

T568A - Front view of socket showing pin / pair assignment

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