Construction and Wiring Guidelines for Ergon Energy Substation Panels

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PURPOSE AND SCOPE

To outline Ergon Energy requirements for acceptance of construction and wiring of Control, Protection, Communications, Metering and Auxiliary Equipment Panels within Ergon Energy Substations.

Specific wiring and construction standards in Ergon Energy drawings or Standards and Australian Standards take precedence over the requirements outlined in this Reference.

The requirements of AS/NZS 3000 Wiring Rules shall be followed at all times.

RESPONSIBILITIES

The **Executive General Manager Network Optimisation** is the Process Owner responsible for approving this Reference.

The **General Manager Substations** is the Subject Matter Expert (SME) for the content of this Reference.

The **Commissioning and Maintenance Manager** is responsible for implementing and maintaining this Reference.

The **Manager Management Systems** is responsible for the endorsement of this Reference prior to submission for approval.

DEFINITIONS, ABBREVIATIONS AND ACRONYMS

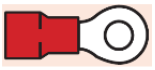
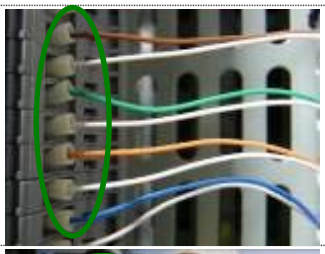
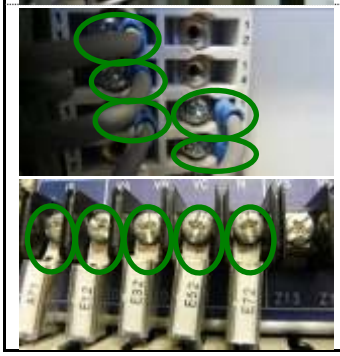
RTU Remote Terminal Unit

REFERENCES

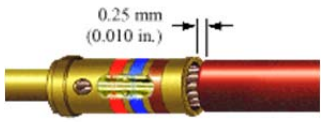
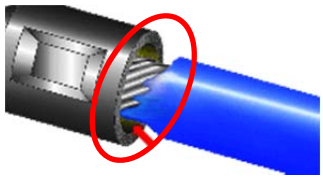
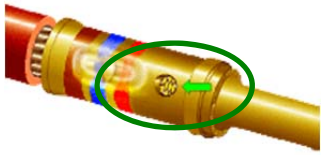
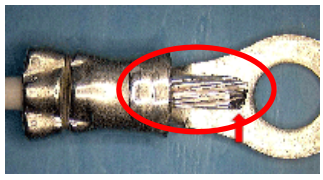
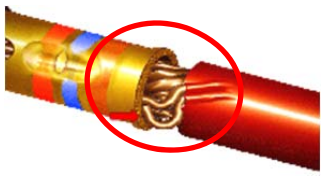
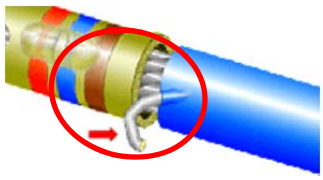
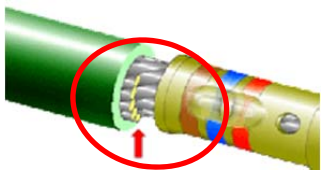
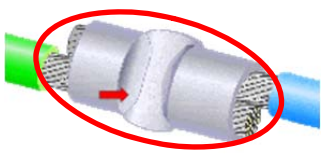
AS/NZS 3000 Wiring Rules

PANEL WIRING

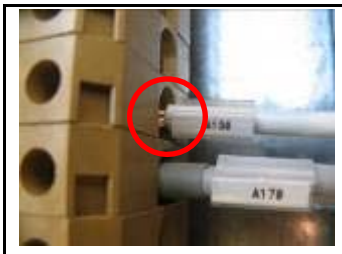
Crimp Terminations

Multi-stranded Conductors	Multi-stranded conductors with strands greater than or equal to 0.5 mm diameter (i.e. 7/0.50 1.5 mm^2 and above) do not require crimp terminations, except as described below. These wires can be stripped and terminated directly under a tunnel type terminal. Conductor strands shall not be wound together after stripping. Hard drawn conductors are not permitted.
 Ring  Bootlace  Flat Blade  Forked Spade  Receptacle Spade	Multi-stranded conductors of 1 mm^2 cross sectional area and below, and flexible conductors of stranding less than 0.5 mm diameter, must be terminated with a crimp fitting except when indicated by the terminal manufacturer. Any crimp termination used must suit the connecting terminal. The termination must be made in accordance with the manufacturers' specifications. Round bootlace crimps may be used where terminal screws make direct contact onto the crimp. Flat blade pre-insulated crimps must be used where the contact surface is a flat plate. In this situation, bootlace crimps are not to be used as the terminal surface exerts insufficient pressure on the bootlace except when indicated by the terminal manufacturer, e.g. ABB distribution terminal. Care must be taken when using flat terminals to confirm that the blade is aligned correctly in the terminal and the plates are parallel when secured. Forked spade terminals are suitable for use on relays where the connection is made on a centre screw arrangement (e.g. Izumi). The fork surrounds the screw, and its concave washer together with the terminal housing form a solid clamp which stops the fork fingers from spreading. Receptacle terminals are only permitted when specified by the equipment manufacturer. All crimps shall be fitted using the correct crimping tool.
	Round bootlace crimp fittings or pre-insulated flat pin crimp connectors shall be used on RTU terminal blocks using communication wiring.
	Some relay and other instrument terminal blocks require specific crimps. Where this is the case only these specific crimps shall be used.

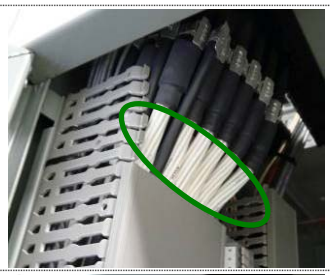
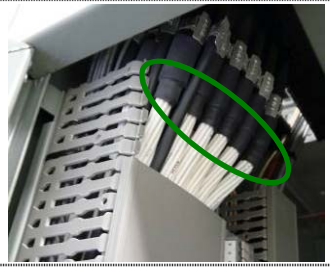
Crimping Practices

	The distance between the insulation and crimp terminal shall be between 0.25 mm and 1 mm.
	Strip insulation with a wire stripping tool to make a clean cut.
	The end of the wire must be visible in crimp terminals which have an inspection hole. This is to confirm the conductor has been properly inserted.
	The conductor must not extend beyond the conductor crimp edge.
	Strands of the conductor are not to be bent when inserted into a crimp.
	Strands are not to protrude out from the crimp. If they protrude, they are not to be cut but shall be redone.
	Strands are not to be trimmed if the crimp barrel is too small for the conductor.
	Joining wires using crimps, solder, or other connection techniques is not acceptable.
Crimp Deformation	The crimps are not to be cut, trimmed or modified (bending, twisting, etc.) in any way.

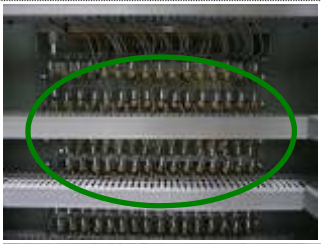
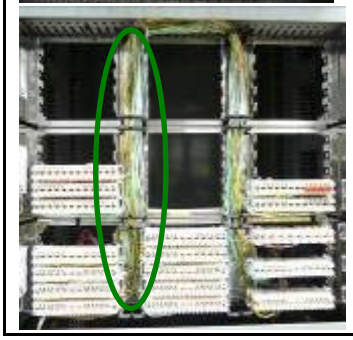
Terminating Wires

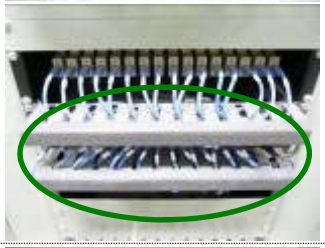
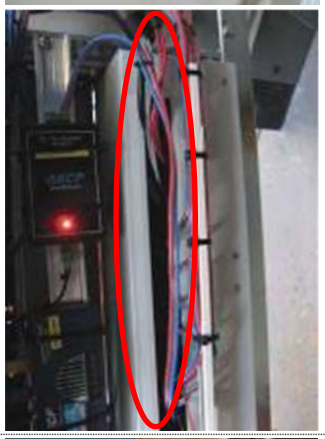
	Wire insulation shall be stripped long enough to enable the securing screw to attach to the bare conductor. The wire must be inserted to the end of the terminal block. If exposed copper can be seen, the wire must be trimmed and reinserted. Conductor strands must not be trimmed if the terminal is not large enough to fit the conductor. Wires shall be fastened tightly into terminal blocks so that they cannot be pulled out when given a firm tug with long nose pliers.
	No terminal will have more than two connections. Wires shall be crimped individually to simplify the fault finding process. However, wires can be crimped together if: i) specified on the drawing, or ii) a crimp designed for two conductors is used. Each wire shall have 150 mm slack for the implementation of additional crimps (following fault-finding) if two wires are crimped together.

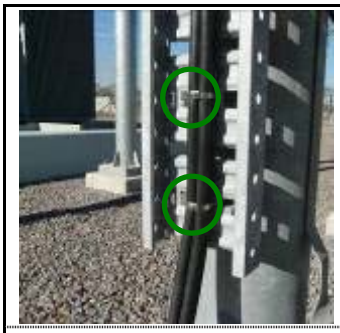
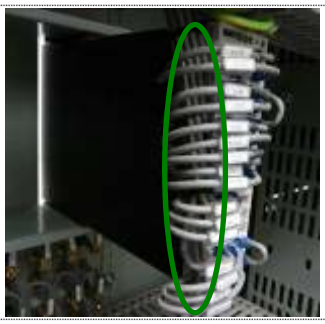
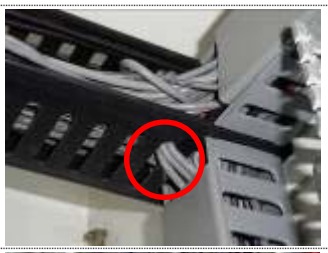
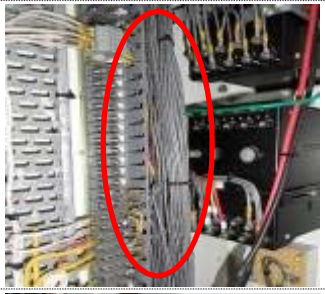
Control Cables

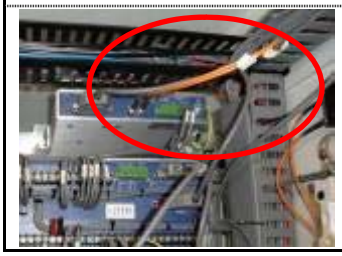
Cable Support	Multicore cables shall be fitted with cable glands, cable clamps or cable ties as appropriate prior to the cable termination point. Where multicore cables enter marshalling boxes via glands and the cable is adequately supported, the use of cable clamps in addition to the glands is not required. Plastic cable glands must not be used outdoors. The weight of multicore cables shall be taken by the cable gland, clamp or cable ties and no pressure or tension shall be exerted on the terminal.
	The outer sheath of the multicore cable shall be removed immediately beyond the terminating gland, cable clamp or cable tie-off point.
	Heat shrink shall be installed on the control cable at the transition point between the sheath and the exposed cores.
Clean Wires / Cables	All jute and fillers shall be removed from the sheathing of the cable and wires before crimping is undertaken.

Wiring within a Panel

	Cores which are not required in new multicore cables shall be labelled as spares at either end. Cores which are made redundant due to the removal of functions shall be labelled as spares at either end. Spare cores are not to be cut short. There must be enough length, on each spare core, to reach any terminal on the associated rail. They are to remain in the duct with the ends covered in heat shrink. Each spare core shall be labelled with the cable number. The wire is then to be laid back and neatly secured to the parent cable. The wires do not need to be bonded to earth; however they must be untwisted from the group of cores to allow easy access for future work.
	Where practicable, wires shall be contained within the ducts and exit closest to the connection point on the panel equipment.
	In this situation, wires have not been passed through the corresponding holes in the cable ducts. This is not acceptable.
Wire Size	Panel wiring shall be grey PVC insulated 2.5 mm^2 for CT and VT circuits and 1.5 mm^2 for all other wiring (excluding bus wiring) unless otherwise specified. Earth wiring to be 2.5 mm^2 green / yellow unless otherwise specified.
 	Wires shall be routed in a neat, easy to trace manner. They should travel through the ducts and exit at the appropriate point. Sufficient length of wiring is required such that replacing a panel component shall neither require disconnecting wiring from other equipment on the rack or in the panel, nor disturbing wiring in the ducts or looms. See additional picture below.

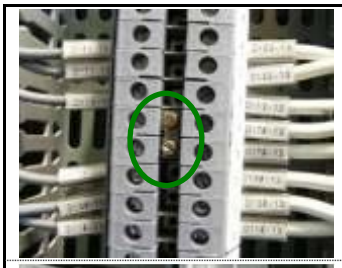
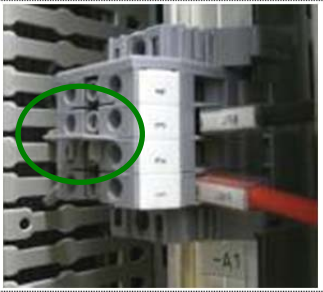
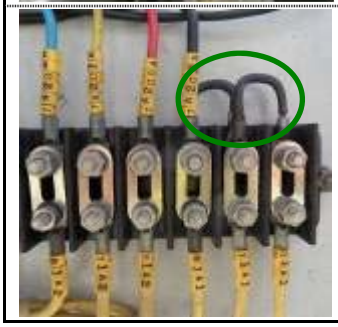
 	Cable tidies and cable entry plate (with brush insert) shall be utilised where wiring is required on the front of panels.
 	Wires shall be grouped together with cable ties where multiple wires travel on the same path. They are not to be left loose. Spiral binding or split loom tubing is acceptable instead of cable ties. Old cable ties shall be removed if additional wiring is added to a loom.
	Where a frame is available, the wire shall be secured to the inside to minimise the possibility of damage from knocks. Note in this situation the wires have neither been secured together, nor secured on the inside of the rail. The earth wire has also been left with a loose loop.

	Plastic cable ties shall be used for indoor cables. Outdoor cables shall be tied with stainless steel cable ties. UV resistant plastic cable ties are also acceptable.
Control Cable Orientation	Cables entering a terminal from a duct shall enter the terminal strip on the side closest to the duct. All field cables entering the panel shall terminate on the side of the terminal furthest from the front of the panel.
	Wires shall be grouped and loomed as shown when it leaves the duct to provide a neat wire layout and adequate additional slack to be able to remove and replace wiring for testing without disturbing other wiring.
Wiring to CT Secondary Terminal Blocks	Wiring to CT secondary terminal blocks or ratio selection terminals shall have sufficient length so that any secondary ratio or polarity can be connected.
	Wires are not to stick out of the ducts. Once inside a cable duct they are to follow the cable duct paths without cutting through corners.
	Ducts shall be chosen of sufficient size for the amount of cables travelling through them. The duct lid must be able to fit on the ducts.
	Wires must fit neatly inside the cable ducts with the tops on.

	If there are too many cables for the duct, it is acceptable to cut the cover short to allow the majority of the duct to be covered. All cable cores shall be straightened, removing all kinks and twists when laid out. This reduces the amount of space occupied by cores in the cable ducts. It also makes wiring to other sections of the panel easier in the future.
CT and VT Sliders	If vertical mounting is specified, CT sliders shall be installed so that if the slide was to fall it would close links and not open circuit the CT secondary. If vertical mounting is specified, VT sliders shall be installed, the opposite to CT sliders, such that if VT sliders fall it will open the links.
Mains Power	No exposed mains wiring is acceptable within the equipment cubicle.
	Optical fibre patch cables shall not be run externally to cubicles, between cubicles, or to a wall mounted Optical Termination Panel unless they are protected within a dedicated optical fibre duct or conduit or of heavy-duty construction and installed in a separate cable tray (communications cable tray) from the control cables. Excess length in fibre optic patch cables shall be neatly loomed and fastened in a position where it is not exposed to damage.

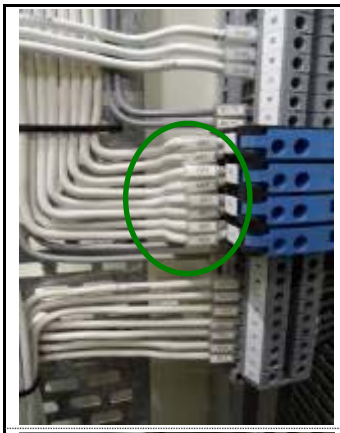
BRIDGING

Bridging within Terminal Blocks

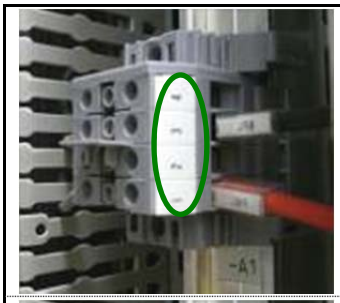
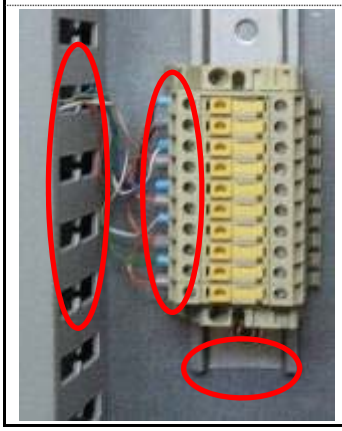
	Any bridging within a terminal shall be done with terminal block solid bar bridges if specified on the design drawings. Substitution with a wire loop is not permitted.
	Suitable insulating inserts must be used when bridging adjacent terminal blocks to avoid shorting.
	Where the terminal does not allow a link bar to be used, or the design drawing permits, wires can be used to neatly loop between links.

LABELLING

Wire Numbers

	Wire number ferrules shall be placed near the termination on either end of the wire. The wire number must be legible, and placed in a location where it can be read without disturbing other wires. Wire numbers on horizontal wires shall read left to right. Wire numbers on vertical wires shall read bottom to top.
	Wire numbers shall all be legible. They must all be read from left to right or bottom to top. They are not to be misaligned. Handwritten wire or cable numbers are not acceptable.
	A single wire number ferrule may be placed in the centre of the wire if the wire is sufficiently short such that both terminations of the wire can easily be seen. A wire number ferrule is not required when the bridging wire is too short to fit the ferrule.
	Insulation tape shall not be used for cable identification.

Terminal Blocks

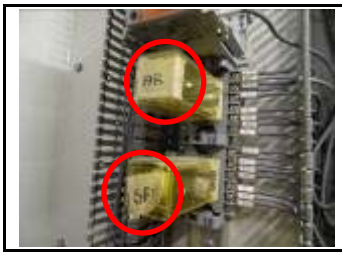
	Individual terminal blocks shall be labelled.
	Each terminal group shall be labelled.
Manufacturer Accessories	Unless otherwise specified, manufacturer proprietary accessories such as end plates and bridging links shall be used.
	In this situation the terminals have not been numbered, nor have the cables entered the correct holes in the ducting. This is not acceptable.

Cable Numbers

	Stainless Steel labels (or alternative permanent marking system) shall be placed around the sheathing of cables close to where the sheathing has been stripped. Control cable numbers must be fitted where the cable enters the panel or cubicle.

	All cables shall be labelled.
 	The cable number shall be mounted external to switchboards or cubicles when the terminated end of the cable cannot be seen due to physical barrier.
	The cables have not been labelled with the appropriate labels. Temporary labels are permitted for construction use only, and must be removed and replaced with permanent labels before commissioning occurs.
	Labelling cables with a pen either directly on the cable or on tape is not acceptable.

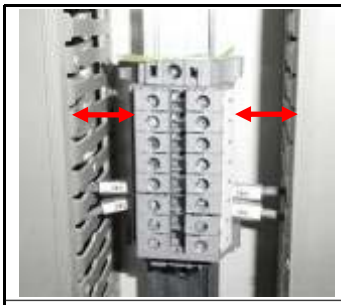
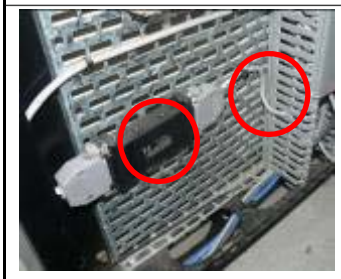
Relays and Devices

	Identification labels must be applied adjacent to the relay or devices. They are not to be placed on covers or the device itself unless accompanied by an adjacent label. Handwritten or other temporary labels are not to be used.

Cubicle and Rack

Cubicle Labels	Where possible, labels shall be fitted to the front and rear of each cubicle in a central top position.
Spare Rack Space	Where specified, unused rack space shall have blanking panels fitted.

PLACEMENT

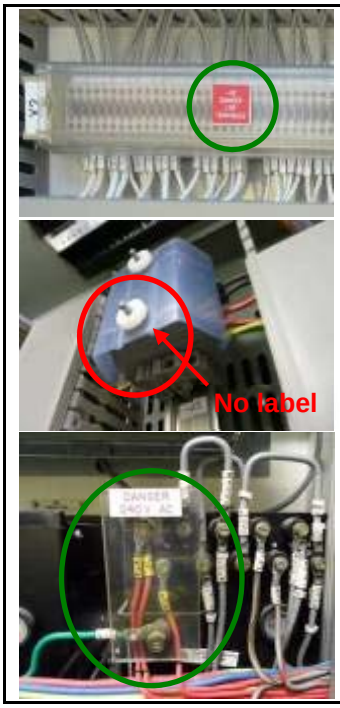
	Where practicable, a minimum spacing of 40 mm between terminal blocks and main ducts shall be used.
Supports	All equipment shall be installed into cubicles in accordance with the manufacturers' installation instructions. Equipment shall be fixed into the 19-inch racks using a minimum of four (4) M6 setscrews and corresponding captive nuts. Heavy equipment shall be supported by extra side rails or shelves as required.
	Equipment with nameplate information attached to the device must be installed with the information visible. It should also be placed in the most practical installation position. This optical isolator was placed back to front, covering the device specific information. It was not centred when attached to the cable tray. Had it been centred, the cable numbers on both cables could be placed close to their ends.

COVERS

Unused Ports

	Any unused fuse places on the front of panels will have their holes covered with suitable plugs.
	Blanking plates must be installed on unused ports. Covering with duct tape is not acceptable.

Shrouding Contacts

	Dangerous live elements must be shrouded and labelled accordingly.

EARTHING

 	Earth wires shall be clearly labelled and individually attached to an earthing bar. Earth wires are not to be stacked with multiple connections to the one point on new installations. Earthing conductors shall be terminated by means of crimped lugs unless approved terminals or clamping devices are provided.
Control Cable Screens	Control cable screens shall be earthed at both ends of the cable, excluding signal cables (such as Decron) which are earthed at one end only (preferably where the signal equipment is earthed, i.e. at the RTU).

CABLE CONDUITS

	Open ends of cable conduits shall not be left unfilled.
	A suitable fill must be used on the ends of cable conduits. The fill must be a fire and oil resistant breakable sealant material. In outdoor applications the fill must be resistant to UV degradation – expanding foam is not suitable (even if painted). A grout cap is the preferred fill for outdoor situations.
Edge Protection	Where entry or exit points are required from the side or bottom of closed mesh or perforated trays, neat round or rectangular holes shall be cut with the edges de-burred and provided with edge protection such as grommet strip or similar.

CABLE TRAYS AND LADDERS

Spare Capacity	All cable trays and ladders shall have a spare capacity of at least 25% of tray or ladder width after all cables are installed.
Orientation	In a stacked cable tray system the cables shall be arranged with power cables positioned above control and instrumentation cables.
Minimum Height	Where cable trays and ladders are installed in plant rooms or across walkways, the minimum clear height from floor or ground level to underside of tray or ladder is 2.1 metres.
Cable Protection	Cables which can be exposed to direct sunlight or are vulnerable to damage from falling objects or build-up of spillage material must have a continuous galvanised steel cable tray or ladder covers fitted.

CABLE PENETRATION FIRESTOPS AND FIRE BREAKS

Firestops	Firestops shall be used to prevent fire propagation along a cable system. The firestop shall have a fire rating equal to or greater than the wall or floor it penetrates. Modifications or additions of cables shall not compromise the integrity of the firestop. Cable firestops must be used when sleeve or tray penetrations are used beneath control panels or other panels. Removable firestop bags or similar may be used as a temporary measure during installation, but at the completion of the installation, permanent firestops shall be applied.