EC Plug Fans in AHU Applications

Best Practice Guide 1st edition

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1. INTRODUCTION

The purpose of this document is to outline the installation procedure and recommended practices in the use of electronically commutated RadiPac centrifugal fans (EC plug fans) in air handling units (AHUs).

This guideline covers:

- wall and foot mounted applications and installation space
- use of anti-vibration mounts (AVMs)
- inlet and exhaust side guarding
- power and control wiring, including suggestions for fire mode
- troubleshooting a non-operating fan
- check and maintenance schedule

2. EC PLUG FAN OVERVIEW

EC plug fans provide a compact and high efficiency solution for air handling units.

The high performance impeller, motor and electronics system are all optimally adjusted to one another, leading to an overall efficiency of well above 60%. A significant contribution to this efficiency is made by the external rotor design GreenTech EC motor. This is a mains-powered, permanently-energised synchronous motor with electronic commutation. An important feature of these motors is the integrated variable speed drive (VSD) that allows for simple speed control, PI control with sensor input or MODBUS high level interface (HLI) connection over RS485.

The electronics and motor form one unit, which is a key advantage of EC plug fans over conventional fans. Not only does the singular unit feature save space, the reduced quantity of components required increases reliability and reduces installation time.

3. EC PLUG FAN AVAILABILITY

Control type is 0-10V & MODBUS EC.

Part number	Assembly Type[1]	Description	Fan Diameter (mm)	Voltage (V)	Phase (~)	Protection Class[2]	Power Input	Maximum Current[3]	Min. Ambient Temperature (°C)	Max. Ambient Temperature (°C)	Wiring Diagram	Approx. Weight (kg)	Lead or Junction Box (mm or JB)	AV Mount[4]	FlowGrid
K3G250PR04H2	S	RadiPac II	250	230	1~	Standard	500	2.3	-25	40	P5	8.5	1000	YES	YES
K3G250PR1 7I9	S	RadiPac II	250	230	1~	Standard	750	3.3	-25	40	P5	8.9	3000	YES	YES
K3G280PR0 4I2	S	RadiPac II	280	230V	1~	Standard	750	3.3	-25	45	P5	9.1	1000	YES	YES
K3G310AZ8802	S	RadiPac	310	400V	3~	Standard	3240	4.9	-25	40	M3	24.2	JB	YES	YES
K3G355PH4932	S	RadiPac II	355	400V	3~	KTL	1900	3.0	-25	55	M3	23.0	JB	YES	YES
K3G400AY8702	S	RadiPac	400	400V	3~	Standard	1850	2.9	-25	50	M3	26.0	JB	YES	NO
K3G450PA23B1	S	RadiPac II	450	400V	3~	KTL	2900	4.5	-25	60	M5	37.0	JB	YES	YES
K3G450PA2809	S	RadiPac II	450	400V	3~	Standard	2900	4.5	-25	60	M3	37.0	JB	YES	YES
K3G500PA2371	S	RadiPac II	500	400V	3~	Standard	3450	5.3	-25	40	M5	38.7	JB	YES	YES
K3G500PB3331	S	RadiPac II	500	400V	3~	KTL	5700	9.0	-25	40	M3	45.5	JB	YES	YES
K3G560RB3175	S	RadiCal	560	400V	3~	Standard	2900	4.4	-25	55	M5	47.8	JB	YES	NO
K3G560PC0431	S	RadiPac II	560	400V	3~	KTL	5000	7.7	-25	40	M3	68.0	JB	YES	YES
K3G630AR0201	C	RadiPac	630	400V	3~	Standard	6750	10.3	-25	50	M3	125.0	JB	YES	YES
K3G630RB3271	S	RadiCal	630	400V	3~	Standard	2800	4.2	-25	55	M5	55.0	JB	YES	YES
K3G630PV0401	C	RadiPac II	630	400V	3~	Standard	7060	10.8	-25	40	M3	98.1	JB	YES	YES
K3G710PV0501	C	RadiPac II	710	400V	3~	Standard	7350	11.2	-25	40	M3	127.4	JB	YES	YES
K3G800PY1301	C	RadiPac II	800	400V	3~	Standard	7950	12.1	-25	40	M3	147.0	JB	YES	YES
K3G900AR1001	C	RadiPac	900	400V	3~	Standard	7520	11.5	-25	40	M3	222.0	JB	YES	NO

1. S=Spider Mount, C=Cube design
2. KTL Version Protection Class: Higher protection to corrosion (e.g. swimming pool applications).
3. Nominal data in operating point with maximum load.
4. Fan is designed for wall installation only. Mounting frames will need to be sourced for installation of anti-vibration mounts for floor or horizontal applications.

Table 1: EC Plug Fans typically available ex-stock Melbourne

4. INSTALLATION

4.1. MOUNTING TYPES AND FAN GRID CONFIGURATION

Depending on the airflow required, space available and required redundancy, the mounting arrangement used will vary from one application to the next.

Figure 1: Supporting "spider" mounting brackets for the RadiPac and RadiPac II EC plug fans

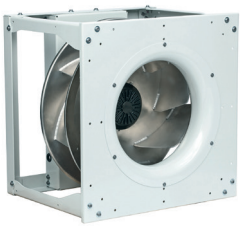


Figure 2: Cube mounting available for 630, 710, 800 and 900 RadiPac EC plug fan sizes

When retrofitting less efficient belt-driven fans in air handling unit (AHU) applications, size is an important consideration. Smaller EC plug fan models are easier to fit through existing access doors, can improve air flow and cooling capacity, and add redundancy to the AHU system. Spider mounting for EC plug fans is typically used for smaller fan sizes (i.e. fans from size 250 to 560) compatible for fan grid formation.

When considering EC plug fans for an upgrade or retrofit project, it is recommended to replace the large belt driven fan with a spider mounted EC plug fan grid for wall mounting that delivers equivalent air performance.

Larger EC plug fan models ranging from size 630 up to size 900 are available with cube design for floor mounting which offers increased stability with the further increase in mass of larger EC plug fan models. Cube mounted EC plug fans can be further upgraded to include anti-vibration mounts.

EC plug fans have the benefit of pressurising the space they discharge into, allowing ducting to be cut wherever required.

4.2. INSTALLATION SPACE

The installation space of EC plug fans can affect the air performance of the implemented fan grid system on AHU applications.

When selecting an EC plug fan, it is recommended to allow a minimum of ½ fan diameter between the impeller and AHU wall to ensure uniform airflow across the heat exchanger air coils. A uniform airflow is important to minimise discrepancies in the heat transfer process. A minimum of one fan diameter between any two impellers is recommended to ensure laminar airflow. The use of baffle or separation plates between fans is not required unless noise is a critical consideration factor.

Also consider access to the terminal box of each fan for wiring purposes. In the case of multiple fan installations, ensure adequate room for removal of fans if necessary.

To calculate the effect of the installation space on fan performance, see Figure 3, where:

dh = Hydraulic diameter, using formula dh = 2 x W x H / (W + H)
W = Width of the box
H = Height of the box
D = Outside diameter of the fan

The recommended clearance at the inlet section of the fan can be equated to half of the fan impeller diameter (labelled as D in Fig. 3).

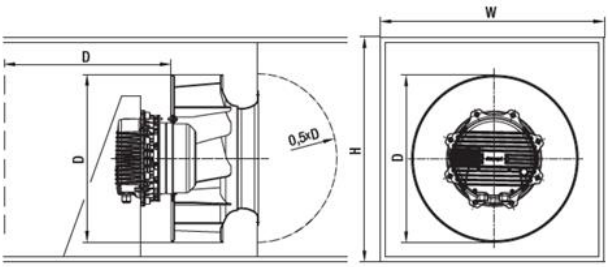


Fig. 3: EC plug fan in a rectangular or square enclosure

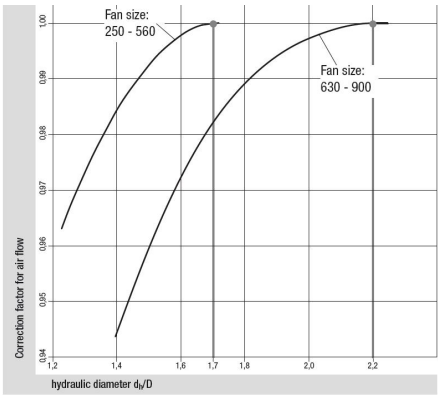


Fig. 4: Optimising EC plug fan air performance

Fig. 4 shows that given the dimensions of the enclosure, its corresponding hydraulic diameter can be calculated and used to determine the corresponding air flow correction factor. Note that optimal air performance of EC plug fans is achieved by having a correction factor equal to 1.00.

4.3. ANTI-VIBRATION MOUNTS

The strategic design of fan systems is required such that the fan speed, and the vibration caused by the rotational speed, does not cause the system to operate in a region of resonance. A fan operated at a speed that excites the system's resonant frequency can lead to the destruction of the system.

ebm-papst EC plug fans are designed such that the maximum operating speed is lower than the resonance frequency, resulting in fan systems that can be rigidly mounted without the need for AVMs.

AVMs are used in situations where the reduction of structure-borne noise is required. When selecting AVMs for use in these applications, it is important to consider the level of vibration isolation required, and the minimum operating speed of the fan.

AVMs from ebm-papst are designed to achieve the best decoupling effect possible. Each set of four AVMs must be matched to the respective fan. A separate set must be used for each fan installed.

When the fan is in operation, care must be taken to ensure that the specified minimum speed indicated on the installed AVMs is avoided. This will prevent the fan from being operated continuously in the resonant frequency. Operation close to or in the resonance frequency may cause irreversible damage to the fan.

AVMs from ebm-papst can be categorised into two types: rubber and spring mounts.

- Rubber mounts are suitable for low vibration isolation, where the EC plug fan is used constantly at relatively high speeds.
- Spring mounts offer greater vibration isolation, as well as greater fan speed operating ranges.

For a complete listing of AVMs available from ebm-papst please refer to the *Anti-Vibration Mounts for RadiPac Centrifugal Fans* catalogue, available as a PDF download on our website.

4.4. ANTI-VIBRATION MOUNT SELECTION PROCESS

The selection of AVMs is critical, as an incorrectly utilised mount can be ineffective in its aim to reduce transmission of the structure-borne noise, or cause the fan system to operate in resonance, leading to damage and premature failure of the fan. It is important to note that adding AVMs will change the speed at which resonance occurs.

The new resonant frequency is governed by the selected AVMs, which is generally based on the isolation efficiency required, the spring deflection and the fan operating speed range.

Care must be taken to ensure that the fan is operated at speeds higher than the specified minimum speed indicated on the AVMs.

Table 2 on page 8 highlights the potential applications of AVMs in some of the available EC plug fans currently offered at ebm-papst A&NZ. The AVMs are supplied in sets of four.

Table 2: Anti-Vibration Mounts for EC Plug Fans

Fan Model	Part Number	Min. capacity[2]	Min. speed	Part Number	Min. capacity[2]	Min. speed	Part Number	Min. capacity[2]	Min. speed
K3G250PR17I9[1]	AVRM-CT1	46% capacity	1600 RPM	AVSM-CT6	18% capacity	610 RPM	AVSM-CT8	11% capacity	385 RPM
K3G280PR04I2[1]	AVRM-CT1	53% capacity	1600 RPM	AVSM-CT6	20% capacity	610 RPM	AVSM-CT8	13% capacity	385 RPM
K3G310AZ8802[1]	AVRM-CT1	23% capacity	960 RPM	AVSM-CT6	9% capacity	370 RPM	AVSM-CT9	7% capacity	290 RPM
K3G355PH4932[1]	AVRM-CT1	35% capacity	1000 RPM	AVSM-CT6	13% capacity	380 RPM	AVSM-CT9	10% capacity	300 RPM
K3G355AY4002[1]	AVRM-CT1	38% capacity	1000 RPM	AVSM-CT6	15% capacity	380 RPM	AVSM-CT9	12% capacity	300 RPM
K3G400AY8702[1]	AVRM-CT1	43% capacity	940 RPM	AVSM-CT6	17% capacity	360 RPM	AVSM-CT9	13% capacity	280 RPM
K3G450PA23B1[1]	AVRM-CT1	37% capacity	800 RPM	AVSM-CT4	17% capacity	370 RPM	AVSM-CT5	14% capacity	290 RPM
K3G450PA2809[1]	AVRM-CT1	37% capacity	800 RPM	AVSM-CT4	17% capacity	370 RPM	AVSM-CT5	14% capacity	290 RPM
K3G500PB3331[1]	AVRM-CT1	32% capacity	720 RPM	AVSM-CT4	15% capacity	330 RPM	AVSM-CT5	12% capacity	270 RPM
K3G500PA2371[1]	AVRM-CT1	42% capacity	800 RPM	AVSM-CT4	19% capacity	360 RPM	AVSM-CT5	15% capacity	290 RPM
K3G560RB3175[1]	AVRM-CT1	42% capacity	700 RPM	AVSM-CT4	20% capacity	325 RPM	AVSM-CT5	16% capacity	260 RPM
K3G560PC0431[1]	AVRM-CT3	40% capacity	700 RPM	AVSM-CT7	22% capacity	380 RPM	AVSM-CT10	15% capacity	270 RPM
K3G630AR0201	AVRM-CT2	52% capacity	780 RPM	AVSM-CT1	27% capacity	400 RPM	AVSM-CT3	17% capacity	250 RPM
K3G630PV0401	AVRM-CT4	51% capacity	900 RPM	AVSM-CT7	19% capacity	330 RPM	AVSM-CT3	17% capacity	290 RPM
K3G630RB3271[1]	AVRM-CT1	60% capacity	780 RPM	AVSM-CT7	33% capacity	425 RPM	AVSM-CT10	23% capacity	300 RPM
K3G710AR0301	AVRM-CT2	58% capacity	750 RPM	AVSM-CT1	26% capacity	344 RPM	AVSM-CT11	22% capacity	280 RPM
K3G710PV0501	AVRM-CT4	55% capacity	790 RPM	AVSM-CT1	28% capacity	400 RPM	AVSM-CT11	22% capacity	310 RPM
K3G800PV1301	AVRM-CT2	66% capacity	800 RPM	AVSM-CT1	31% capacity	380 RPM	AVSM-CT11	24% capacity	290 RPM
K3G800AR0801	AVRM-CT2	66% capacity	690 RPM	AVSM-CT1	30% capacity	320 RPM	AVSM-CT11	25% capacity	260 RPM
K3G900AR1001	AVRM-CT2	75% capacity	645 RPM	AVSM-CT2	44% capacity	382 RPM	N/A	N/A	N/A

[1] Designed for wall installation only. Mounting frames need to be sourced for installation of anti-vibration mounts for floor or horizontal applications. [2] Percentage of full air flow capacity

Outlined below are AVMs that are typically available ex stock:

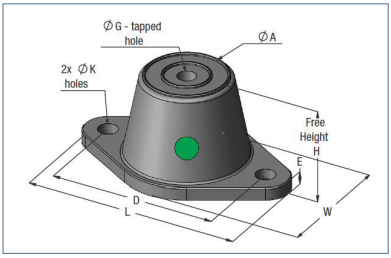


Fig. 5: Rubber Mounts

Part #	Max. load kg	Static Deflection mm	Height (H) mm	L mm	W mm	D mm	A mm	G mm	K mm	E mm
AVRM-CT1	17	8	35	80	45	60	36	M10	8.5	5
AVRM-CT2	70	10	44	98	60	76	45	M10	8.5	6
AVRM-CT3	25	8	35	80	45	60	36	M10	8.5	5

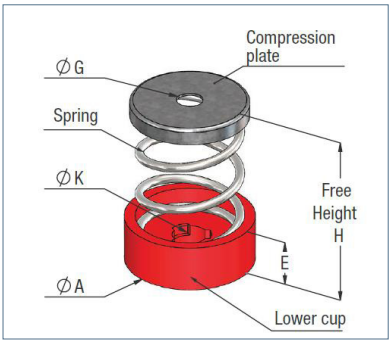


Fig. 6: Spring Mounts

Part #	Max. load kg	Static Deflection mm	Height (H) mm	A mm	G mm	K mm	E mm	Colour
AVSM-CT1	50	28	84	60	12	16	12	Black
AVSM-CT2	75	25	84	60	12	16	12	Red
AVSM-CT4	15	33	84	60	12	16	12	Brown
AVSM-CT6	10	33	84	60	12	16	12	Yellow
AVSM-CT7	30	33	84	60	12	16	12	Blue

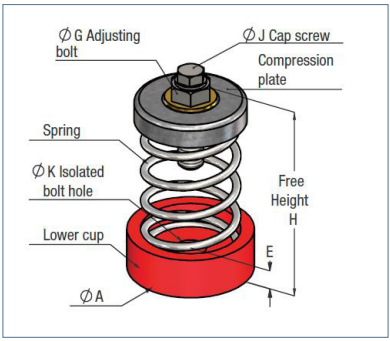


Fig. 7: Spring Mounts

Part Number	Max. load kg	Static Deflection mm	Height (H) mm	A mm	G mm	J mm	K mm	E mm	Constant kg/mm	Colour
AVSM-CT5	14	50	137	80	M16	M10	20	13	0.28	White/ Violet
AVSM-CT8	6	50	137	80	M16	M10	20	13	0.12	Black/ Black
AVSM-CT9	9	50	137	80	M16	M10	20	13	0.18	White/ White
AVSM-CT10	22	50	137	80	M16	M10	20	13	0.44	Violet/ Violet
AVSM-CT11	22	50	137	80	M16	M10	20	13	1.10	Yellow/ Yellow

4.5. GUARDING ACCESSORIES AND SAFETY

Guarding components are used in AHU applications to reduce the tendency of unwanted debris to enter the fan and its internal components, as well as to reduce the hazards associated with handling the fan during its operational periods.

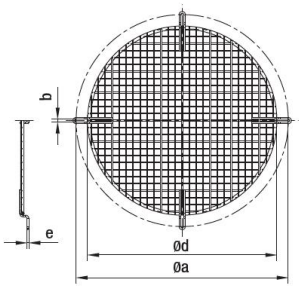
Mesh guarding can be implemented on the discharge side of the RadiPac centrifugal fan, irrespective of its mounting configuration, which should be compliant with *AS/NZS 4024.1801:2014 Safety of machinery Safety distances to prevent danger zones being reached by upper and lower limbs*.

Intake finger guards offered at ebm-papst are applicable for fan diameters ranging from 250 mm to 900 mm. Table 3 outlines the specifications of the available finger guards for EC plug fans.

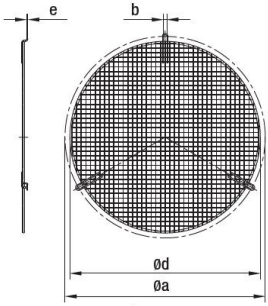
Part Number	Fan Size	Version	a	b	d	e	Strut Division
79280-2-4039	250, 280	1	280	4.5	227	2.8	4 x 90°
79310-2-4039	310	1	325	4.5	271	2.8	4 x 90°
79355-2-4039	355	1	345	4.5	308	2.8	4 x 90°
79400-2-4039	400	2	390	8.5	343	2.8	3 x 120°
79450-2-4039	450	2	430	8.5	381	2.8	3 x 120°
79500-2-4039	500	2	445	8.5	417	2.8	3 x 120°
79560-2-4039	560	2	490	8.5	466	2.8	3 x 120°
79630-2-4039	630	3	600	8.5	551	3.9	3 x 120°
79710-2-4039	710, 800	3	700	8.5	651	3.9	3 x 120°
79900-2-4039	900	4	850	8.5	801	3.9	6 x 60°

Table 3: Intake finger guard compatible with available EC plug fans

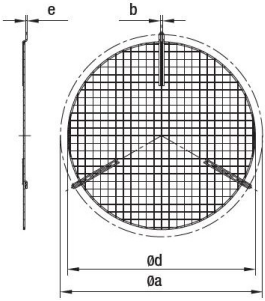
Version 1



Version 2



Version 3



Version 4

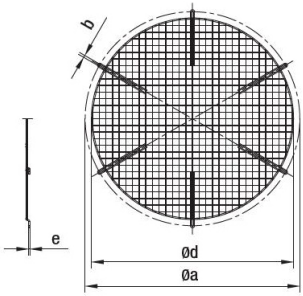


Fig. 8: Guard Versions

4.6. FLOWGRID

The FlowGrid is a type of grille that is attached to the air intake side of the fan. It reduces noise without affecting the efficiency of the fan, and avoids or reduces the need for passive noise reduction solutions.

Fig. 9: FlowGrid

The effectiveness of the FlowGrid depends on the installation conditions of the fan. In AHUs, A-rated noise reduction of up to 3.3dB(A) and a reduction of up to 9dB sound pressure at the blade passing frequency have been measured. It is important to note that the FlowGrid is not a guard grille and cannot be used as a protection device. Table 4 lists suitable FlowGrids for ebm-papst EC Plug fans.

Part Number	FlowGrid p/n	Part Number	FlowGrid p/n
K3G250PR17I9	20280-2-2957	K3G450PA2809	35505-2-2957
K3G280PR04I2	20280-2-2957	K3G500PB3331	35505-2-2957
K3G310AZ8802	25310-2-2957[1]	K3G500PA2371	35505-2-2957
K3G355PH4932	00400-2-2957	K3G560RB3175	-
K3G400AY8702	-	K3G560PC0431	00630-2-2957[2]
K3G450PA23B1	35505-2-2957	K3G630RB3271	00630-2-2957[2]

[1] Mounting only possible at inlet ring. [2] Mounting only possible at front plate.

Table 4: Suitable FlowGrid part numbers for ebm-papst EC Plug fans

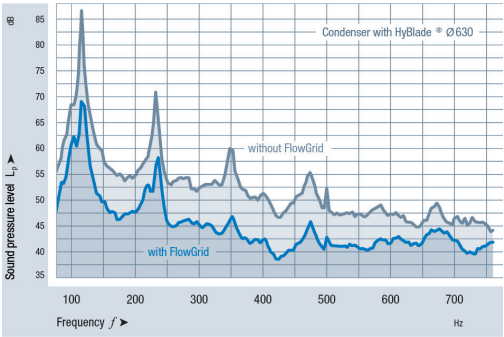


Fig. 10: FlowGrid Comparison Chart

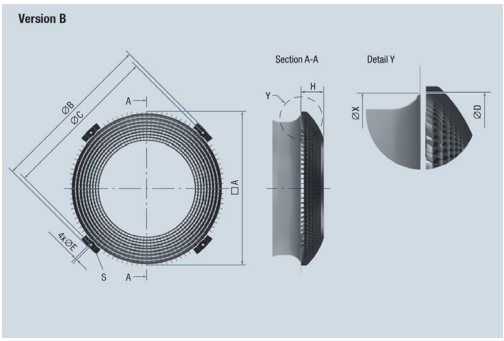


Fig. 11: FlowGrid Dimension Measurements

Part Number	ØA	ØB	ØC	ØD	ØE	S	H	N	ØU
20280-2-2957	-	280	245-260	245	4.5	3.5	40	2±0.5 Nm	12
25310-2-2957	-	315	288-292	282	5.5	3.5	49	2±0.5 Nm	12
00400-2-2957	-	365	335-345	325	4.5	3.5	56	2±0.5 Nm	12
35505-2-2957	-	470	438-442	412	9	3.5	71	10±2 Nm	20
00630-2-2957	-	580	543-547	532	10	3.0	84	10±2 Nm	20
50710-2-2957	590	666	628-632	580	10	3.0	106	10±2 Nm	20
63000-2-2957	734	785	748-752	724	10	3.0	125	10±2 Nm	20
80000-2-2957	930	995	958-962	920	10	3.5	131	10±2 Nm	20
91000-2-2957	1035	1105	1073-1077	1025	10	3.5	161	10±2 Nm	20

Table 5: Dimensions of FlowGrid

5. POWER AND CONTROL WIRING

The following section shows the different terminal layouts and suggested wiring for ebm-papst EC plug fans.

ebm-papst EC plug fans are versatile in their control functionality, and can offer speed control in the following ways:

- analogue control from an external building management system (BMS) or controller, typically 0-10VDC
- closed loop control (PI control) based on direct input from sensors, where sensor output can be 0-10V or 4-20mA
- high level interface (HLI) communication and/or control via MODBUS or BACnet (additional EC Gateway required) over RS485
- any of the above with the inclusion of fire mode functionality

Where EC plug fans are used for closed loop control, HLI communication or control, or for the inclusion of fire mode functionality, some programming of the fan is required. ebm-papst provides fan programming services tailored to the customer requirements and fan application. Service fees may apply.

To enable fan recognition on external gateways and/or controllers, each fan will need to be individually addressed, taking the following into consideration:

- ebm-papst gateways and/or controllers will not automatically assign addresses to the fans that are required on its network. EC-Control is to be used to assign addresses to the respective fans.
- ebm-papst recommends that the first fan to be programmed at address 2 and the following fans thereafter to be programmed at “n+1”. This is to avoid any confusion when a new fan unit is to be added to an existing network. ebm-papst fans are by factory default addressed 1.
- Ensure that the fans are not connected to ebm-papst gateways and/or controllers before the device has been appropriately programmed.

When wiring EC plug fans please consider the following:

Power Wiring

- Refer to the product specific operating instructions for safety guidelines and recommended cable size when connecting power wiring.
- Shielded cables are not required for use on power cables.
- Where multiple fans are installed in one AHU, one isolator should be installed per AHU close to the fan access door, with individual circuit breakers for each fan.
- Single phase / three phase mains power must be connected; do not use the output from a variable speed drive to power an EC plug fan.

Control wiring

- Refer to the product specific operating instructions for safety guidelines and recommended cable size when connecting control wiring.
- Ensure that the RSA, RSB, 0-10V input, +10V output and ground of each fan are accessible at an external location away from both the single phase/three phase power supply connections. Suitable connector boxes are available from ebm-papst.
- Where MODBUS over RS485 is used, appropriate shielded cables should be used.

Please note that the use of conduits is not required for ebm-papst EC plug fans. If conduits are specified or preferred, then the cable glands used on the EC plug fan will need to be changed.

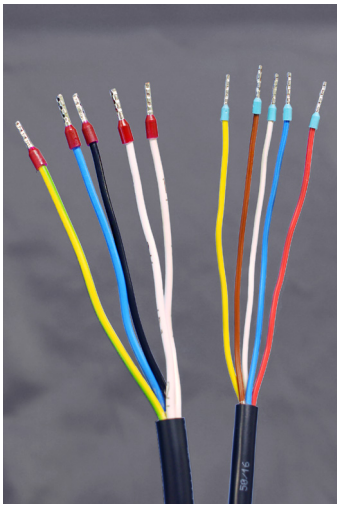
Additional information on power and control wiring

Please contact ebm-papst A&NZ for further information concerning the wiring configurations utilised on EC plug fans. Refer to contact information on the back cover.

5.1 SINGLE-PHASE EC PLUG FANS (P5 WIRING INTERFACE)

Refer to Table 1 for a list of commonly used P5 fan models.

Single-phase EC plug fans contain a P5 wiring interface via cable connection. The following power and control wiring connections are shown in Fig. 12.



Wiring	Connection	Colour
Power	PE	green/yellow
Power	N	blue
Power	L	black
Relay	NC	white 1
Relay	COM	white 2
Control	0-10 V / PWM	yellow
Control	RSB	brown
Control	RSA	white
Control	GND	blue
Control	10V	red

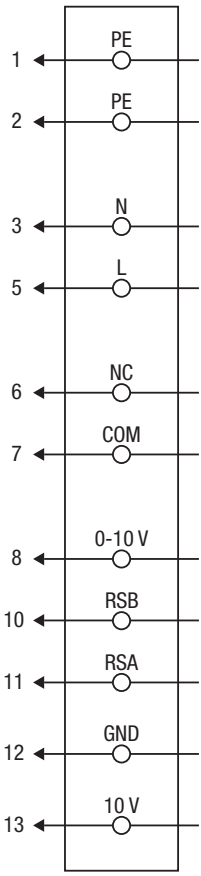


Fig. 12: P5 Wiring Diagram

P5 Power wiring

Terminals marked as 'L' and 'N' in Figure 12 pertain to the power supply terminal found on ebm-papst single-phase fans. PE is the protective earth terminal.

Power input specifications for single-phase EC plug fans can be found in Table 1 on page 2. See appendix for recommended power wiring diagram.

P5 Status relay

Status relay connection is done via the NC (terminal 6) and COM (terminal 7) terminals. When mains power is not applied to the fan (i.e. the fan is not energised) the NC – COM circuit will be open. This contact relay is normally closed but will open upon fan faults, including:

- motor overheat
- electronics overheat
- locked rotor
- hall sensor error

To manage and mitigate faults identified during fan operation, please refer to the relevant operating instructions for more information.

P5 Control wiring

The MODBUS HLI connection is done via the RSA and RSB terminals (terminals 11 and 10 respectively) found on the connection screen (see Figure 12).

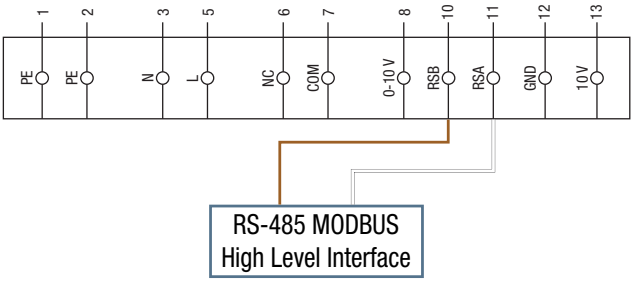
A MODBUS over serial line cable must be shielded. At one end of each cable its shield must be connected to protective ground. An RS485-MODBUS must use a balanced pair (RSA / RSB) and a third wire (GND). AWG 24 is sufficient for the MODBUS data connection. ebm-papst recommends the utilisation of a 120Ω end-of-line (EOL) resistor for RS485-MODBUS communication with EC plug fans that use a P5 wiring interface.

Analogue control is achieved via the 0-10V (terminal 8) and GND (terminal 12) terminals.

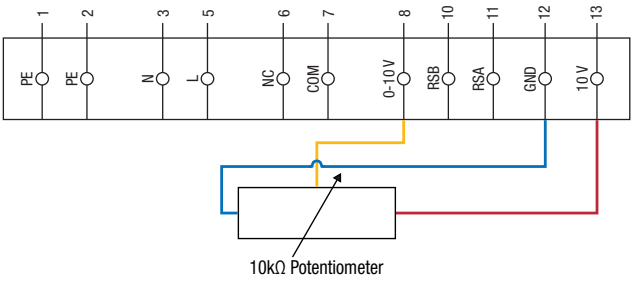
P5 Operating mode schematics

Single-phase EC plug fans can be automated via BMS connection and manually operated via an external potentiometer. Single-phase EC plug fans can have fire mode enabled or be switched off as a response to fire hazards.

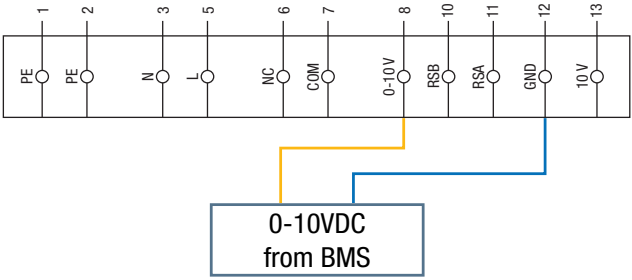
a. P5 RS485-MODBUS HLI control mode



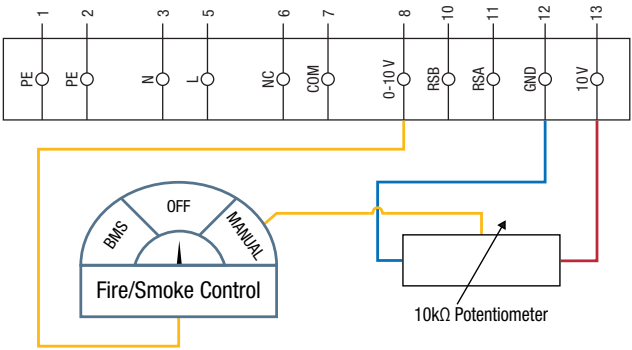
b. P5 Manual control mode



c. P5 BMS control mode



d. P5 Fire control mode (see appendix for electrical wiring diagram)



P5 Additional information

Please contact ebm-papst A&NZ for further information concerning the wiring configurations utilised on EC plug fans with a P5 wiring interface. Refer to contact information on the back cover.

5.2. THREE-PHASE EC PLUG FANS (M3 WIRING INTERFACE)

Refer to Table 1 for a list of commonly used M3 fan models.

Three-phase EC plug fans utilise an M3 wiring interface. The following power and control wiring terminals are shown in Fig. 13.

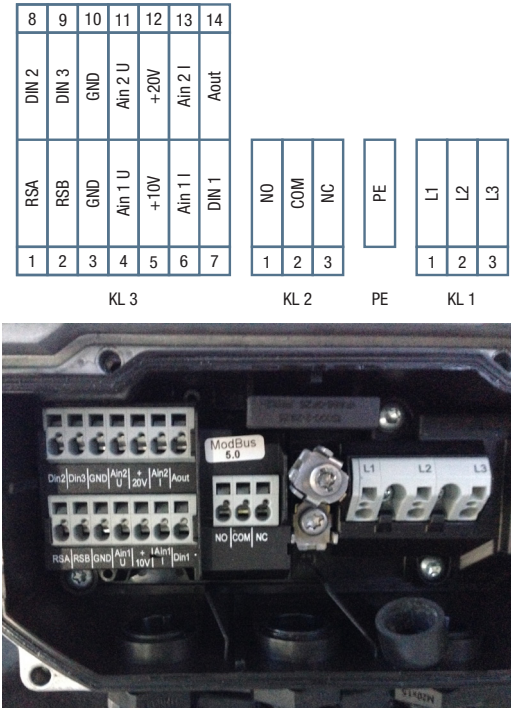


Fig. 13: M3 Wiring Diagram

M3 Power wiring

Power wiring terminals found on the interface (i.e. terminals 1, 2 and 3 denoted on KL1 block in Figure 13) correspond to the power supply connections. PE is the protective earth terminal. See appendix for recommended M3 power wiring diagram.

M3 Status relay

The NO contact relay (terminal 1 on KL2) is normally open but will close upon fan faults, and the NC contact relay (terminal 3 on KL2) is normally closed but will open upon fan faults. When mains power is not applied to the fan (i.e. the fan is not energised) the NC – COM circuit will be open and the NO – COM circuit will be closed. Fan faults include:

- phase failure
- motor overheat
- electronics overheat
- locked rotor
- hall sensor error

To manage and mitigate faults identified during fan operation, please refer to the relevant operating instructions for more information.

M3 Control wiring

The MODBUS HLI connection is done via the RSA and RSB terminals found on the connection screen.

A MODBUS over serial line cable must be shielded. At one end of each cable its shield must be connected to protective ground. An RS485-MODBUS must use a balanced pair (RSA/RSB) and a third wire (GND).

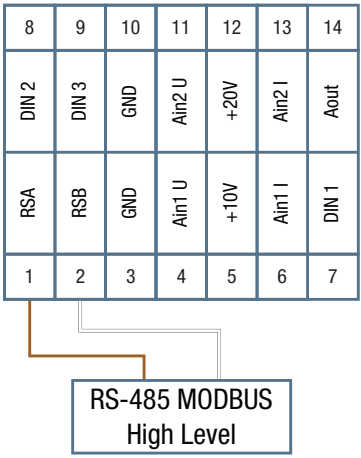
AWG 24 is sufficient for the MODBUS data connection. ebm-papst recommends the utilisation of a 120Ω EOL resistor for RS485-MODBUS communication with EC plug fans that use an M3 wiring interface.

External controls through the BMS control system (i.e. fan speed control) is done via analogue input 1 terminal (Ain1 U/PWM) and GND terminals (terminals 3 and 4 on the KL3 block).

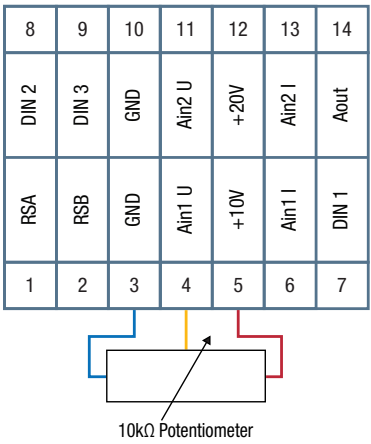
M3 Operating mode schematics

Three-phase EC plug fans that utilise an M3 wiring interface can be automated via BMS connection and manually operated via an external potentiometer. Three-phase EC plug fans can have fire mode enabled or be switched off as a response to fire hazards.

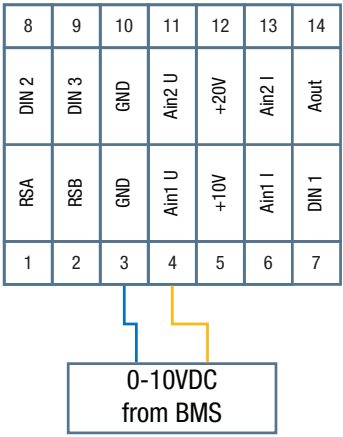
a. M3 RS485-MODBUS HLI control mode



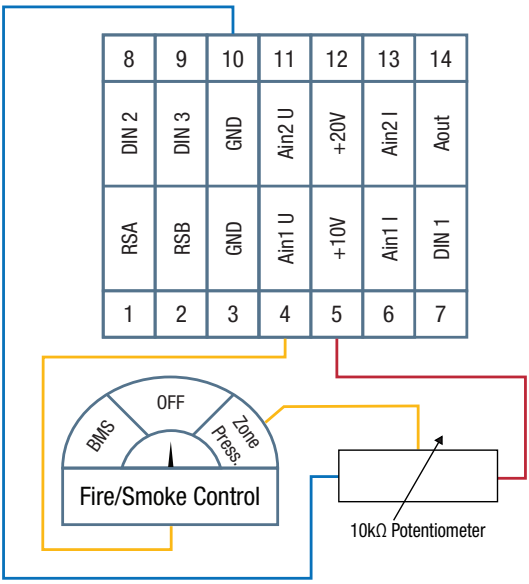
b. M3 Manual control mode



c. M3 BMS (0-10V) control mode



d. M3 Fire control mode (see appendix for electrical wiring diagram)



Note that manual operation of EC plug fans that utilise an M3 wiring interface is essential in the commissioning process to ensure it is fit for operation.

For a fan grid setup, or in any case where multiple EC plug fans are used in a particular application, it is important to connect each of the fans separately to the fire control system for activating (or deactivating) fire mode.

There are other ways to achieve fire mode/zone pressurisation.

M3 Additional information

Please contact ebm-papst A&NZ for further information concerning the wiring configurations utilised on EC plug fans with an M3 wiring interface. Refer to contact information on the back cover.

5.3. THREE-PHASE EC PLUG FANS (M5 WIRING INTERFACE)

Refer to Table 1 for a list of commonly used M5 fan models.

Three-phase EC plug fans utilise an M5 wiring interface. The power and control wiring terminals are shown in Fig. 14

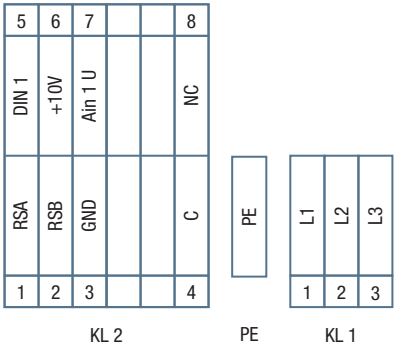


Fig. 14: M5 Wiring Diagram

M5 Power wiring

Power wiring terminals found on the interface (i.e. terminals 1, 2 and 3 denoted on KL1 block in Figure 14) correspond to the power supply connections. PE terminal is the protective earth terminal. See appendix for recommended M5 power wiring diagram.

M5 Status relay

Status relay connection is done via terminals 8 (NC) and 4 (C) (see Figure 14). When mains power is not applied to the fan (i.e. the fan is not energised) the NC – COM circuit will be open. The NC contact relay is normally closed but will open upon fan faults, including:

- phase failure
- motor overheat
- electronics overheat
- locked rotor
- hall sensor error

To manage and mitigate faults identified during fan operation, please refer to the relevant operating instructions for more information.

M5 Control wiring

The MODBUS HLI connection is done via the RSA and RSB terminals found on the connection screen.

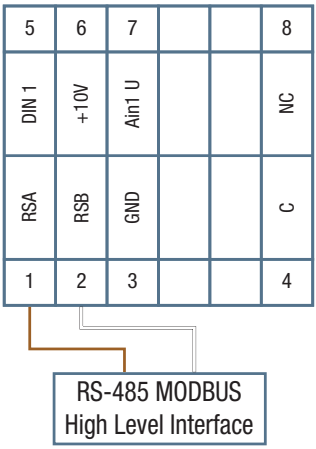
A MODBUS over serial line cable must be shielded. At one end of each cable its shield must be connected to protective ground. An RS485-MODBUS must use a balanced pair (RSA / RSB) and a third wire (GND). AWG 24 is sufficient for the MODBUS data connection. ebm-papst recommends the utilisation of a 120Ω EOL resistor for RS485-MODBUS communication with EC plug fans that use an M5 wiring interface.

External controls through the BMS control system (i.e. fan speed control) is done via analogue input 1 terminal (Ain1 U/PWM) and GND terminals (terminals 3 and 7).

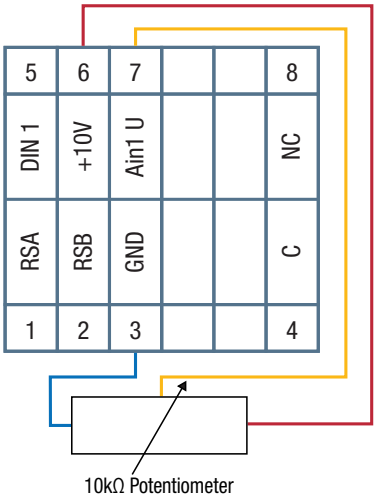
M5 Operating mode schematics

Three-phase EC plug fans that utilise an M5 wiring interface can be automated via BMS connection and manually operated via an external potentiometer. Three-phase EC plug fans can have fire mode enabled or be switched off as a response to fire hazards.

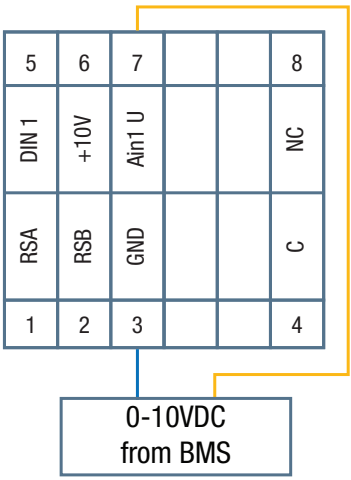
a. M5 RS485-MODBUS HLI control mode



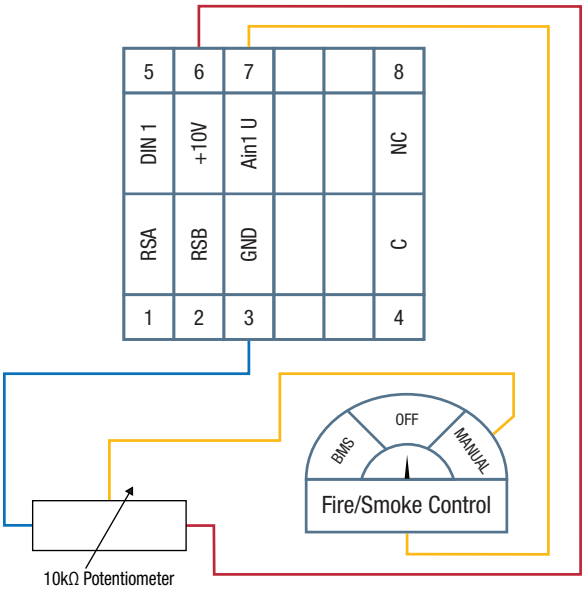
b. M5 Manual control mode



c. M5 BMS (0-10V) control mode



d. M5 Fire control mode (see appendix for electrical wiring diagram)



Note that manual operation of EC plug fans that utilise an M5 wiring interface is essential in the commissioning process to ensure it is fit for operation.

For a fan grid setup, or in any case where multiple EC plug fans are used in a particular application, it is important to connect each of the fans separately to the fire control system for activating (or deactivating) fire mode.

There are other ways to achieve fire mode/zone pressurisation.

M5 Additional information

Please contact ebm-papst A&NZ for further information concerning the wiring configurations utilised on EC plug fans with an M5 wiring interface. Refer to contact information on the back cover.

6. COMMISSIONING

ebm-papst EC plug fans leave the factory with default settings as follows:

- Address: 1
- Source of set value: Analogue
- Control mode: Open loop PWM

For simple commissioning and speed feedback, a combination of potentiometer (part #: CLC000AE0401) and EC MODBUS display (part #: ECMD-001) can be used to manually adjust the fan speed and display an output of fan speed.

For the ability to run the fans or program the fans to run based on various inputs, there are two options:

1. EC-Control laptop based software with USB / RS485 converter interface (part #: 21490-1-0174).
2. Handheld controller (part #: HECC-VBK).

Both of these options allow full controllability of ebm-papst EC plug fans, and feedback of operation parameters.

Technical support

ebm-papst A&NZ offer free training in the connection and use of these devices, as well as full technical support via phone or on site representation. ebm-papst A&NZ also offer programming services to customise fan parameters to suit the requirements on site. Service fees may apply.

Please contact ebm-papst for more details. Refer to contact information on the back cover.

7. TROUBLESHOOTING

Please note that the troubleshooting steps described in this section should only be carried out by suitably qualified persons licensed to perform such work.

7.1. SINGLE-PHASE FANS (P5 WIRING INTERFACE)

a. With the mains power off, check whether the impeller can rotate or spin freely. If not, find and remove any material which is blocking the impeller.

b. Check whether there are any water marks or evidence of presence of water before opening the junction box. If yes, document this before removing the terminal box lid.

c. Note and remove all existing control connections to the fan.

d. With mains power on, measure the mains power supply voltage at the fan terminal box. Match the reading with the fan label and specifications.

e. Measure between +10V (red wire) and GND (blue wire). It should yield an output of +10V with tolerance of ± 3%.

f. If +10V is not present, this suggests the electronics of the fan have been damaged.

g. If +10V is present, check the alarm relays. If NC-COM is open, this indicates a fault state within the fan.

h. If the previous checks are OK, remove the mains power supply and bridge 0-10V/PWM (yellow wire) and +10V (red wire). With the mains power supply on, the fan should spin at its maximum speed if the fan is programmed to source of set value analogue Ain1. Necessary precautions must be taken before attempting to run the fan.

i. If the fan still does not run, fault finding via RSA-RSB (white and brown wire respectively) is to be attempted. This requires ebm-papst EC-Control software and an RS485 USB converter (part #: 21490-1-0174).

7.2. THREE-PHASE FANS (M3 WIRING INTERFACE)

a. With the mains power off, check whether the impeller can rotate or spin freely. If not, find and remove any material which is blocking the impeller.

b. Check whether there are any water marks or evidence of presence of water before opening the junction box. If yes, document this before removing the terminal box lid.

c. Note and remove all existing control connections to the fan.

d. With mains power on, measure the mains power supply voltage at the fan terminal box. Match the reading with the fan label and specifications.

e. Measure between +10V (pin 5 of KL3) and GND (pin 3 or pin 10 of KL3). It should yield an output of +10V with tolerance of ± 3%.

f. Measure between +20V (pin 12 of KL3) and GND (pin 3 or pin 10 of KL3). It should yield an output of +20V with tolerance of +25%/-10%.

g. If +10V and +20V are not present, this suggests the electronics of the fan have been damaged.

h. If +10V and +20V are present, check the alarm relays. If NO-COM is closed and NC-COM is open, this indicates a fault state within the fan.

i. If the previous checks are OK, remove the mains power supply and bridge Ain1 U (pin 4 of KL3) and +10V (pin 5 of KL3). With the mains power supply on, the fan should spin at its maximum speed if the fan is programmed to source of set value analogue Ain1. Necessary precautions must be taken before attempting to run the fan.

j. If the fan still does not run, fault finding via RSA-RSB (pin 1 and pin 2 of KL3) needs to be done. This requires ebm-papst EC-Control software and an RS485 USB converter (part #: 21490-1-0174).

7.3 THREE-PHASE FANS (M5 WIRING INTERFACE)

a. With the mains power off, check whether the impeller can rotate or spin freely. If not, find and remove any material which is blocking the impeller.

b. Check whether there are any water marks or evidence of presence of water before opening the junction box. If yes, document this before removing the terminal box lid.

c. Note and remove all existing control connections to the fan.

d. With mains power on, measure the mains power supply voltage at the fan terminal box. Match the reading with the fan label and specifications.

e. Measure between +10V (pin 5 of KL3) and GND (pin 3 or pin 10 of KL3). It should yield an output of +10V with tolerance of ± 3%.

f. If +10V is not present, this suggests the electronics of the fan have been damaged.

g. If +10V is present, check the alarm relays. If NC-C is open, this indicates a fault state within the fan.

h. If the previous checks are OK, remove the mains power supply and bridge Ain1 U (pin 7 of KL2) and +10V (pin 6 of KL2). With the mains power supply on, the fan should spin at its maximum speed if the fan is programmed to source of set value analogue Ain1. Necessary precautions must be taken before attempting to run the fan.

i. If the fan still does not run, fault finding via RSA-RSB (pin 1 and pin 2 of KL2) needs to be done. This requires ebm-papst EC-Control software and an RS485 USB converter (part #: 21490-1-0174).

SUMMARY OF APPENDIX CONTENTS

This appendix includes the following drawings for reference:

- Power wiring for single and three phase EC plug fans
- Wiring schematic for fire mode with multiple fans with P5 interface
- Control wiring for fans with P5 interface
- Wiring schematic for fire mode with multiple fans with M3 interface
- Control wiring for fans with M3 interface
- Wiring schematic for fire mode with multiple fans with M5 interface
- Control wiring for fans with M5 interface

The drawings contained within are intended only as recommendations. Other wiring configurations may be possible, depending on fan type.

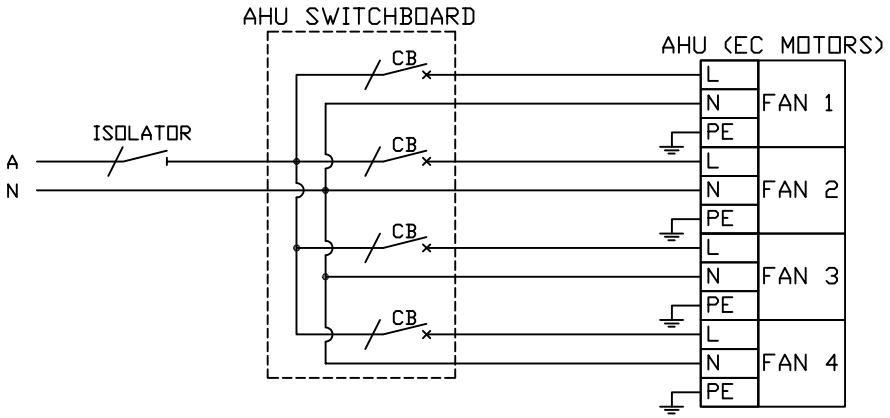
Please consult your nearest ebm-papst A&NZ office for further information:

Melbourne +61 3 9360 6400

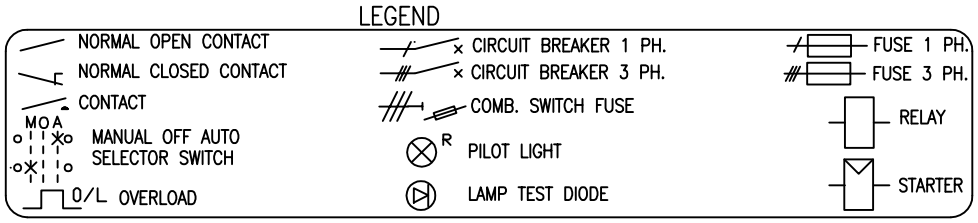
Sydney +61 2 9827 6400

Auckland +64 9 525 0245

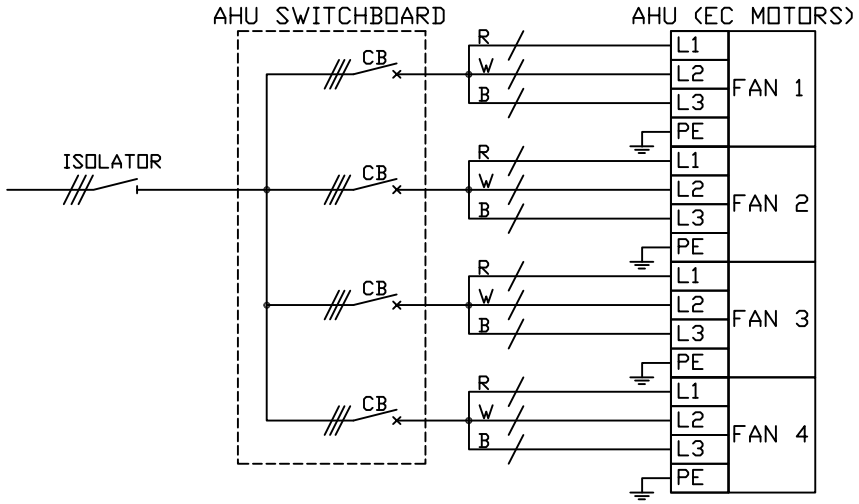
SINGLE PHASE (1 ~)



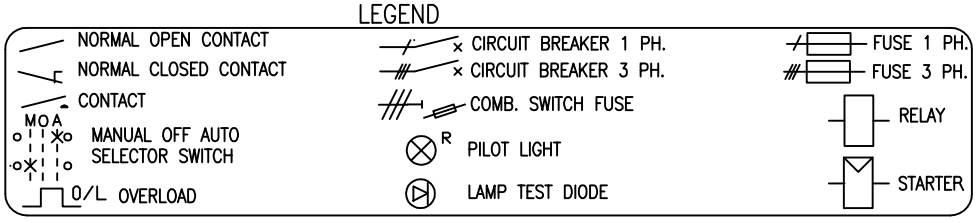
- PROTECTIVE EARTH (PE) WIRING ACCORDING TO EN 61800-5-1
- REFER TO FAN OPERATING INSTRUCTIONS FOR CIRCUIT BREAKER (CB) SPECIFICATIONS

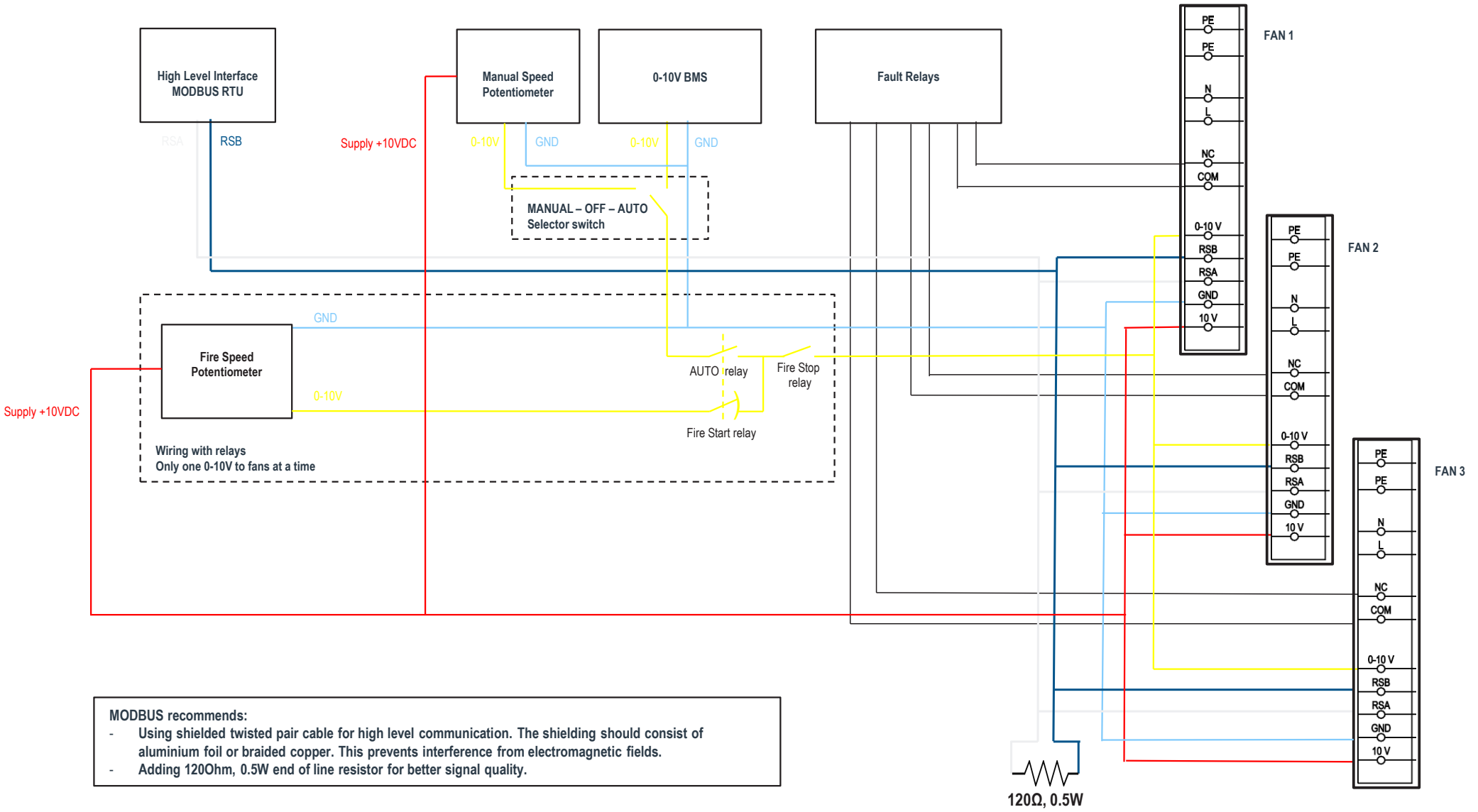


THREE PHASE (3~)



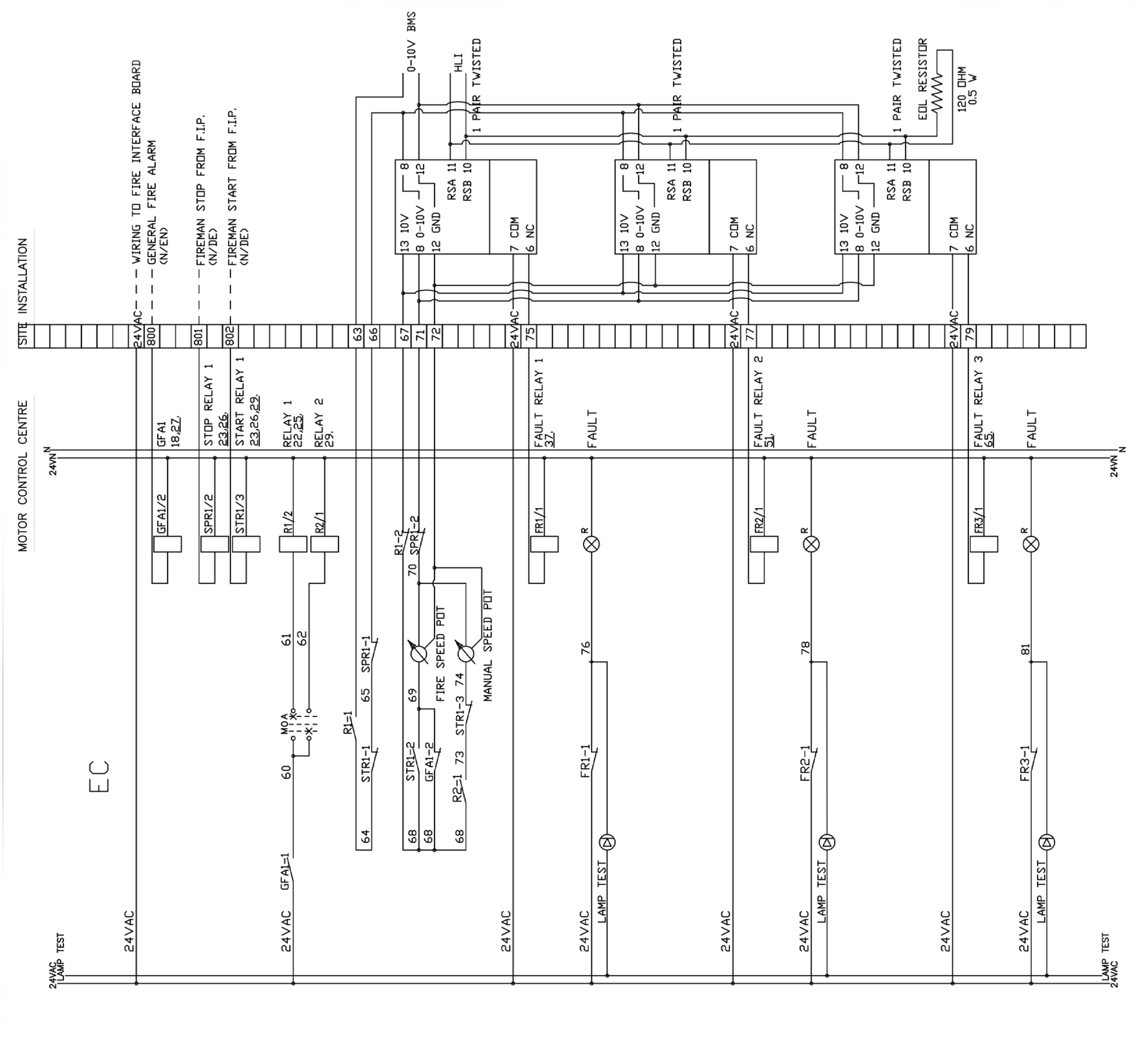
- PROTECTIVE EARTH (PE) WIRING ACCORDING TO EN 61800-5-1
- REFER TO FAN OPERATING INSTRUCTIONS FOR CIRCUIT BREAKER (CB) SPECIFICATIONS





MODBUS recommends:

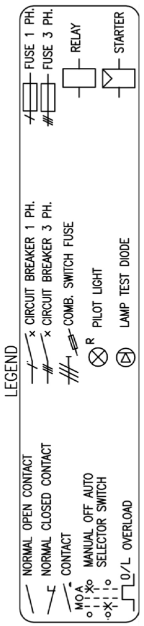
- Using shielded twisted pair cable for high level communication. The shielding should consist of aluminium foil or braided copper. This prevents interference from electromagnetic fields.
- Adding 120Ohm, 0.5W end of line resistor for better signal quality.

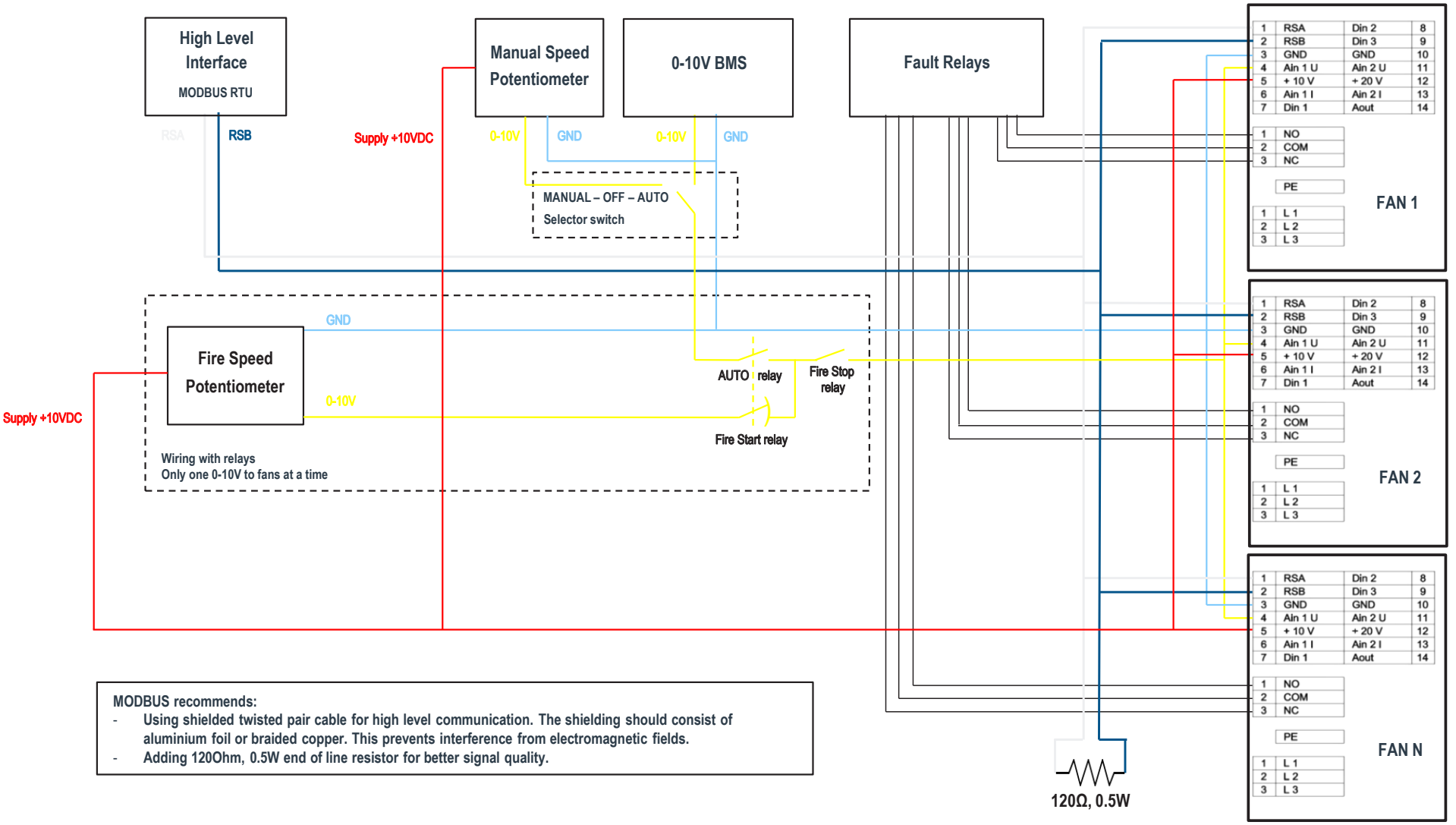


- GFA: GENERAL FIRE ALARM, STOPS FANS ON FIRE ALARM
- SPR: FIREMAN OVERRIDE STOP RELAY
- STR: FIREMAN OVERRIDE START RELAY
- FR: FAULT RELAY
- RELAY 1: AUTO RELAY
- RELAY 2: MANUAL RELAY

MODBUS RECOMMENDS:

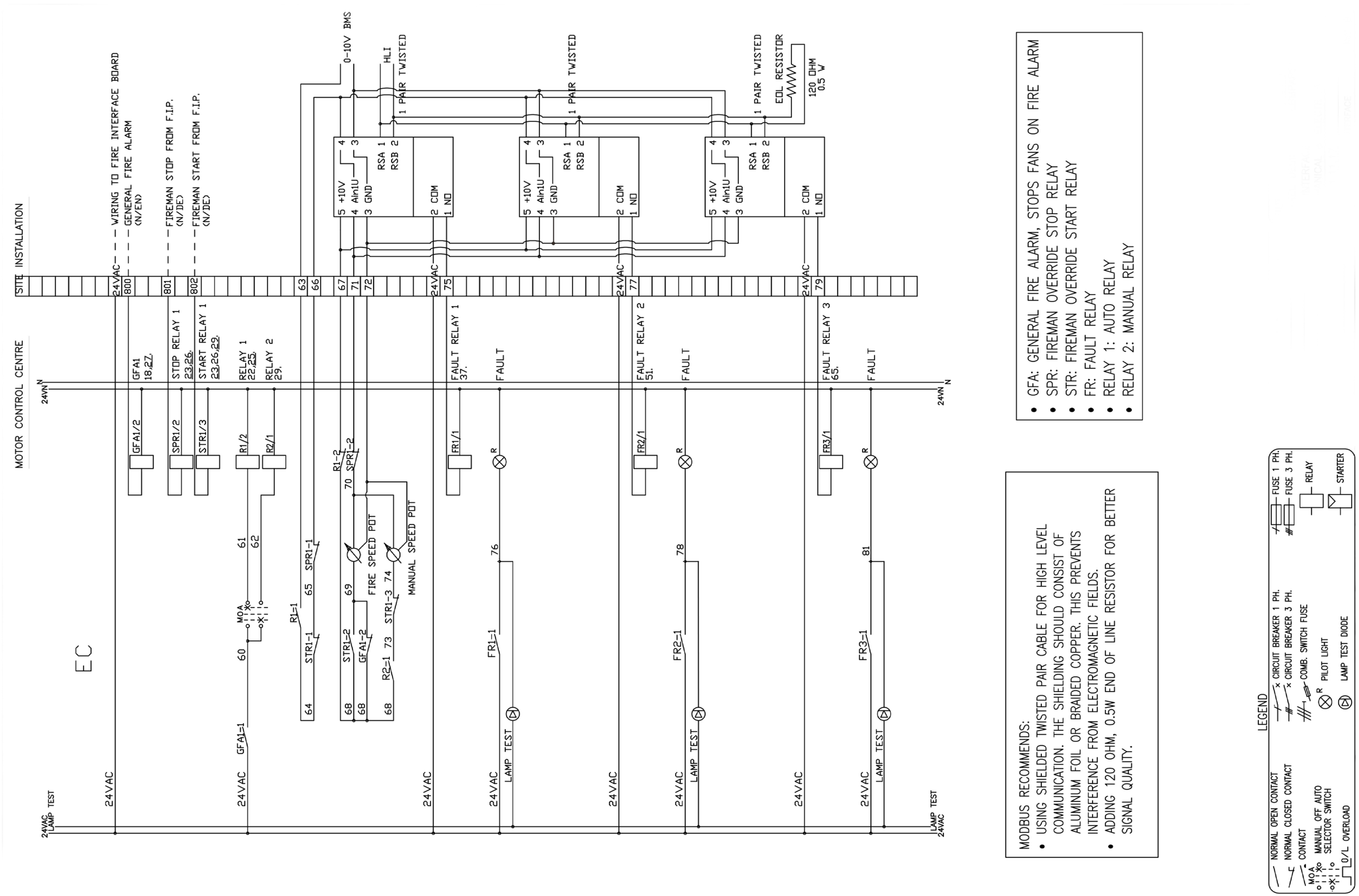
- USING SHIELDED TWISTED PAIR CABLE FOR HIGH LEVEL COMMUNICATION. THE SHIELDING SHOULD CONSIST OF ALUMINUM FOIL OR BRAIDED COPPER. THIS PREVENTS INTERFERENCE FROM ELECTROMAGNETIC FIELDS.
- ADDING 120 OHM, 0.5W END OF LINE RESISTOR FOR BETTER SIGNAL QUALITY.

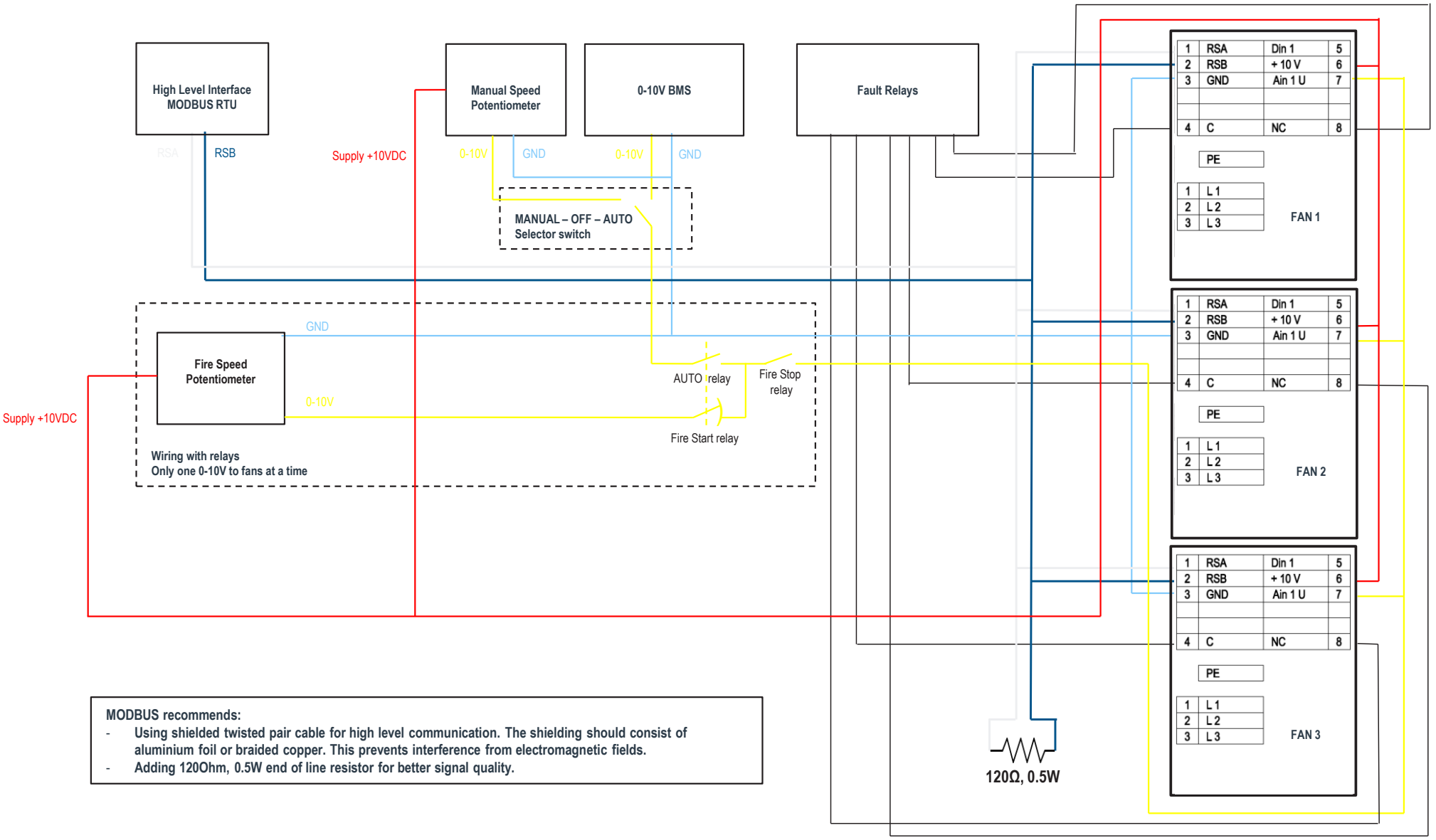




MODBUS recommends:

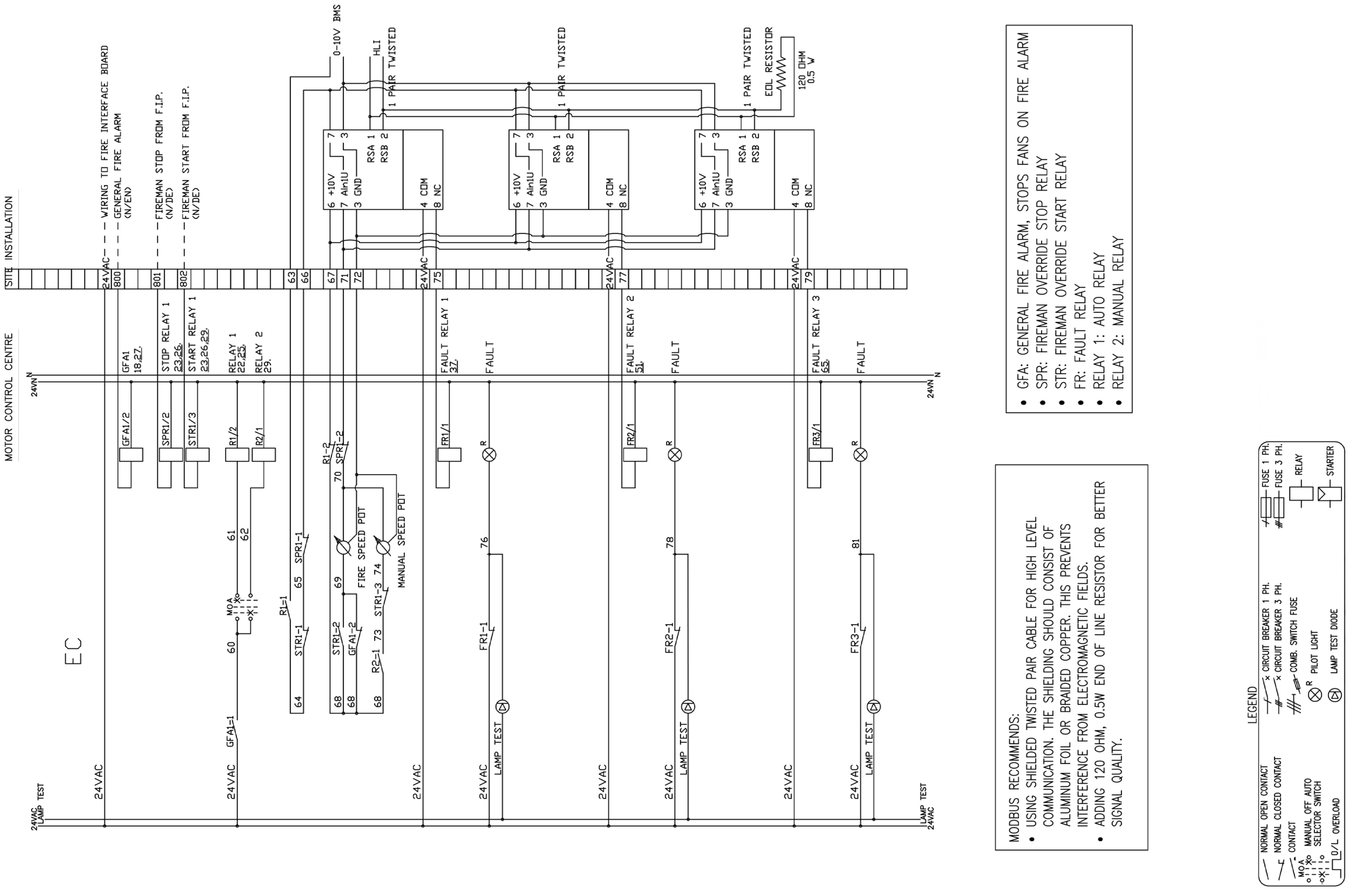
- Using shielded twisted pair cable for high level communication. The shielding should consist of aluminium foil or braided copper. This prevents interference from electromagnetic fields.
- Adding 120Ohm, 0.5W end of line resistor for better signal quality.


SITE INSTALLATION
MOTOR CONTROL CENTRE
WIRING TO FIRE INTERFACE BOARD
GENERAL FIRE ALARM (N/EN)
FIREMAN STOP FROM F.I.P. (N/DE)
FIREMAN START FROM F.I.P. (N/DE)
0-10V BMS
HLI
1 PAIR TWISTED
EOL RESISTOR
120 OHM 0.5 W
5 +10V
4 Ain1U
3 GND
4
3
RSA 1
RSB 2
2 COM
1 NO
24VAC
800
801
802
63
66
67
71
72
75
77
79
GFA1 18,27.
STOP RELAY 1 23,26.
START RELAY 1 23,26,29.
RELAY 1 22,25.
RELAY 2 29.
FAULT RELAY 1 37.
FAULT RELAY 2 51.
FAULT RELAY 3 65.
FAULT
24VN
N
GFA1/2
SPR1/2
STR1/3
R1/2
R2/1
R1-2
SPR1-2
FR1/1
FR2/1
FR3/1
R
61
62
MOA
60
R1-1
SPR1-1
65
STR1-1
64
GFA1-1
FIRE SPEED POT
MANUAL SPEED POT
70
69
STR1-2
GFA1-2
STR1-3
74
R2-1
73
68
76
78
81
FR1-1
FR2-1
FR3-1
LAMP TEST
24VAC LAMP TEST
EC
GFA: GENERAL FIRE ALARM, STOPS FANS ON FIRE ALARM
SPR: FIREMAN OVERRIDE STOP RELAY
STR: FIREMAN OVERRIDE START RELAY
FR: FAULT RELAY
RELAY 1: AUTO RELAY
RELAY 2: MANUAL RELAY
MODBUS RECOMMENDS:
USING SHIELDED TWISTED PAIR CABLE FOR HIGH LEVEL COMMUNICATION. THE SHIELDING SHOULD CONSIST OF ALUMINUM FOIL OR BRAIDED COPPER. THIS PREVENTS INTERFERENCE FROM ELECTROMAGNETIC FIELDS.
ADDING 120 OHM, 0.5W END OF LINE RESISTOR FOR BETTER SIGNAL QUALITY.
LEGEND
NORMAL OPEN CONTACT
NORMAL CLOSED CONTACT
MANUAL OFF AUTO SELECTOR SWITCH
O/L OVERLOAD
CIRCUIT BREAKER 1 PH.
CIRCUIT BREAKER 3 PH.
COMB. SWITCH FUSE
PILOT LIGHT
LAMP TEST DIODE
FUSE 1 PH.
FUSE 3 PH.
RELAY
STARTER



MODBUS recommends:

- Using shielded twisted pair cable for high level communication. The shielding should consist of aluminium foil or braided copper. This prevents interference from electromagnetic fields.
- Adding 120Ohm, 0.5W end of line resistor for better signal quality.


MOTOR CONTROL CENTRE
SITE INSTALLATION
WIRING TO FIRE INTERFACE BOARD
GENERAL FIRE ALARM (N/EN)
FIREMAN STOP FROM F.I.P. (N/DE)
FIREMAN START FROM F.I.P. (N/DE)
0-10V BMS
HLI
1 PAIR TWISTED
EOL RESISTOR
120 OHM 0.5 W
6 +10V
7 Ain1U
3 GND
RSA 1
RSB 2
4 COM
8 NC
GFA1 18,27.
STOP RELAY 1 23,26.
START RELAY 1 23,26,29.
RELAY 1 22,25.
RELAY 2 29.
FAULT RELAY 1 37.
FAULT RELAY 2 51.
FAULT RELAY 3 65.
FAULT
FIRE SPEED POT
MANUAL SPEED POT
LAMP TEST
24VAC
24VN
EC
• GFA: GENERAL FIRE ALARM, STOPS FANS ON FIRE ALARM
• SPR: FIREMAN OVERRIDE STOP RELAY
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LAMP TEST DIODE
FUSE 1 PH.
FUSE 3 PH.
RELAY
STARTER

LIST OF TERMS AND ABBREVIATIONS

AHU: Air Handling Unit

AVM: Anti-Vibration Mount

AWG 24: American Wire Gauge 24 is a type of silicon wire

BACnet: user protocol generally used in Building Automation

BMS: Building Management System

EC-Control: ebm-papst software for programming EC fans

EC plug fan: ebm-papst Radipac EC centrifugal fan

GreenTech: *GreenTech* and the green tick symbol represent the ebm-papst company philosophy for energy efficiency and resource preservation

HLI: High Level Interface

Mains power: refers to Australian and New Zealand power supply standards

DISCLAIMER

This document is provided free of charge as a guide only and is intended for use only by suitably qualified persons with adequate technical training in fans and fan applications.

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