1 INTRODUCTION

This guide is to assist in selecting appropriately sized cabling to provide power between an MGS Gas Detection Controller or suitable power source and remotely mounted MGS Gas Detectors. This guide will also address selecting the appropriate Modbus communications cabling for your MGS application.

This guide serves as a suggestion only. When installing your Gas Detection Controllers and Detectors, please follow any and all applicable local laws, codes, and standards.

Always follow the instructions in the Controller's or Detector's User Manual and/or Quick Start Guide.

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2 POWER CABLE SELECTION

The application in Figure 1 will be used to demonstrate how to select the appropriate power cable gauge for your application.

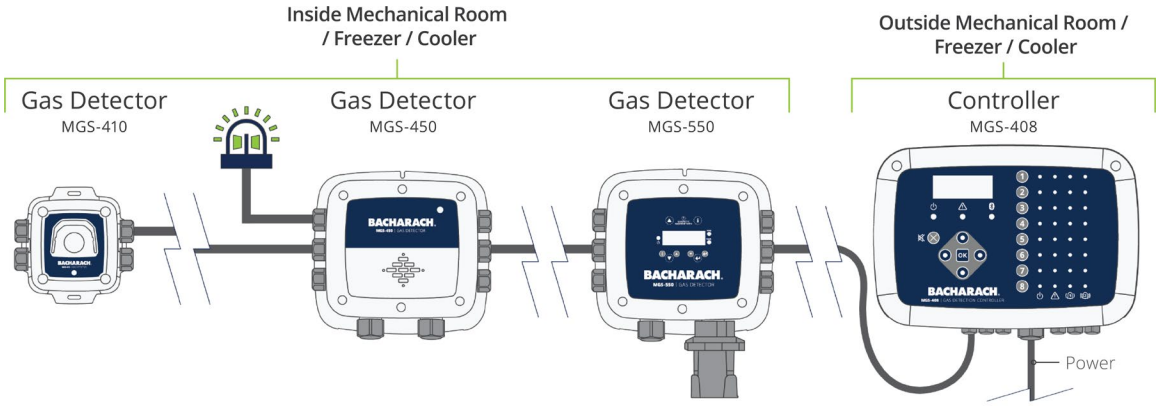

Figure 1. Power Cable Application

The application consists of (1) Gas Detection Controller (MGS-408) and (3) Gas Detectors (MGS-410, MGS-450, and MGS-550)

2.1 Determine Gas Detector Power Load

When determining the appropriately sized power cable for your application, you must first determine the Total Detector Load (TDL) of the detectors in your application. The TDL is the sum of all of the detector loads (Watts) in the application. The TDL will also allow you to determine if the applicable MGS Controller or detector power source can provide the required power to the detectors.

MODEL	LOAD (W)
MGS-250	2.5
MGS-410	4
MGS-450	4
MGS-460	4
MGS-550	8

Figure 3. Gas Detector Max Load

MODEL	LOAD (W)
MGS-408	32
MGS-402	8

Figure 2. Max Allowable Load

Cross referencing Figure 2 and 3, the TDL can be determined. In this example, (1) MGS-410, (1) MGS-450, and (1) MGS-550 Gas Detector are wired to (1) MGS-408 Gas Detection Controller.

MODEL	LOAD (W)	QUANTITY	SUBTOTAL (W)	MAX ALLOWABLE LOAD (W)
MGS-410	4	1	4	
MGS-450	4	1	4	
MGS-550	8	1	8	
		TDL (W)	**16**	**32**

Figure 4. TDL Calculation

Please note the Total Detector Load (16 W) does not exceed the controller's max allowable load (32 W). If the TDL exceeds the max allowable load, fewer detectors, detectors with a lower max loads, or a different Gas Detection Controller must be used.

2.2 Power Wire Gauge Size

2.2.1 Maximum Theoretical Distance

The maximum wire length to the furthest Detector from the Controller is limited by the Modbus communication signal. The Modbus communication cable to the furthest Detector is constrained to 1,000 FT maximum.

2.2.2 Gas Detection Controller Minimum Output Voltage

The Gas Detection Controller's power supply providing Gas Detector power have an initial voltage tolerance, a load dependent tolerance, and a line voltage dependent tolerance. These tolerances combine to produce a worst case Minimum Output Voltage (MOV) that must be taken into consideration. The internal protection circuits of the MGS-402 Controller contribute an additional loss to its MOV compared to the MGS-408 Controller.

MODEL	NOMINAL VOLTAGE (VDC)	TOLERANCE (%)	MOV (VDC)
MGS-408	24	+/- 2.5	**23.4**
MGS-402	24	+/- 4.5	**22.2**

Figure 5. Controller Minimum Output Voltage

2.2.3 Gas Detector Minimum Operating (Input) Voltage

Consult your Detector's User Manual for the Minimum Input Voltage (MIV). See Figure 6 for the MIV of the detectors used in this example.

MODEL	MIV (VDC)
MGS-410	19.5
MGS-450	19.5
MGS-550	19.5

Figure 6. Detector Minimum Input Voltage

2.2.4 Calculate Required Power Wire Gauge

In order to calculate the required power wire gauge, we will assume the furthest detector (MGS-410) from the MGS-408 Controller in Figure 1 requires 800 FT of cable.

We will now calculate the input voltage to this detector using the wire impedance properties found in Figure 7, the minimum output voltage (MOV) of the controller (MGS-408) from Section 2.2.2, and the Total Detector Load (TDL) determined in Section 2.1.

Note: the total length of power wire used is double the cable length between the furthest Detector and its Controller; for this example, that length is 1,600 FT.

WIRE GAUGE (AWG)	DIAMETER (IN)	Resistance (Ω) (PER 1,000 FT)
20	0.0350	10.15
18	0.0480	6.385
16	0.0600	4.016
14	0.0730	2.53
12	0.0960	1.7

Figure 7. Wire Resistance versus Wire Gauge (Typical)

Total Detector Current: $\mathbf{I = \frac{TDL}{MOV} = \frac{16\ W}{23.4\ V} = 0.684\ A}$

Power Cable Voltage Drop: $\mathbf{V_D = I * [\left(\frac{Power\ Wire\ Total\ Length}{1{,}000\ FT}\right) * \left(\frac{Resistance}{1{,}000\ FT}\right)]}$

Input Voltage at Furthest Detector: $\mathbf{V_{IN} = MOV - V_D}$
(V_{IN} must be greater than the MIV in Section 2.2.3)

WIRE GAUGE DETERMINATION

16 AWG $\mathbf{V_D = 0.684\ A * \left[\left(\frac{1{,}600\ FT}{1{,}000\ FT}\right) * (4.016\ \Omega)\right] = 4.4\ V}$ | $\mathbf{V_{IN} = 23.4\ V - 4.4\ V = 19.0\ V < 19.5V}$ X

14 AWG $\mathbf{V_D = 0.684\ A * \left[\left(\frac{1{,}600\ FT}{1{,}000\ FT}\right) * (2.530\ \Omega)\right] = 2.8\ V}$ | $\mathbf{V_{IN} = 23.4\ V - 2.8\ V = 20.6\ V > 19.5V}$ ✓

Conclusion: The application in Figure 1 requires 14 AWG power wire to ensure the input voltage to the furthest Detector exceeds its MIV requirement of 19.5 VDC. The power cabling used must include (2) 14 AWG wires/conductors.

It is possible to use larger gauge wire, but please confirm the input voltage at the furthest Detector, the max allowable cable size for the power terminals in the Controller and Detector(s), and cable diameter (see Section 3.1).

2.2.5 Power Cable Wire Gauge Verification

1) Determine Total Detector Load (TDL), Section 2.1
2) Determine Total Detector Current (I), Section 2.2.4
3) Calculate power cable voltage drop (V_D) at the Total Detector Current (I) using the selected wire gauge's resistance (Figure 7), Section 2.2.4
4) Verify Input Voltage (V_{IN}) to furthest Detector is greater than Minimum Input Voltage (MIV) required, Section 2.2.2)

2.2.6 Quick Power Wire Gauge

A straightforward way to determine the power cable wire gauge needed for an application is by using the table in Figure 8. Wire gauge is determined by calculating the Total Detector Load (Section 2.1) and the distance between the Controller and the farthest Gas Detector.

TOTAL DETECTOR LOAD (W)	MAXIMUM WIRE LENGTH, FT (M)		
	20 AWG	18AWG	16 AWG
2	1,000 (305)	1,000 (305)	1,000 (305)
4	1,000 (305)	1,000 (305)	1,000 (305)
6	724 (221)	1,000 (305)	1,000 (305)
8	543 (166)	861 (263)	1,000 (305)
10	434 (133)	689 (210)	1,000 (305)
12	362 (111)	574 (175)	914 (279)
14	310 (95)	492 (150)	783 (239)
16	271 (83)	430 (132)	685 (209)
18	241 (74)	383 (117)	609 (186)
20	217 (67)	344 (105)	548 (168)
22	197 (61)	313 (96)	498 (152)
24	181 (56)	287 (88)	457 (140)
26	167 (51)	265 (81)	422 (129)
28	155 (48)	246 (75)	392 (120)
30	145 (45)	230 (71)	365 (112)
32	136 (42)	215 (66)	343 (105)

Figure 8. Quick Wire Gauge Table

3 MODBUS COMMUNICATIONS CABLE SELECTION

When selecting a communications cable for an MGS application, for ease of installation, is it recommended that a 4-core cable is used; (2) cores for power cabling, (2) cores for communications cabling. This will reduce material and installation costs when wiring the application.

When necessary, individual 2-core power and communications cables can also be used.

3.1 Cable Gland Size

When selecting a 4-core communications cable, it is important to consider the gland sizes available on the MGS Product line:

MODEL	GLAND SIZES	MAX CABLE DIAMETER
MGS-402	(2) M20, (6) M16	(2) Ø 0.394” – 0.55”, (6) Ø 0.158” – 0.315”
MGS-408	(2) M20, (6) M16	(2) Ø 0.394” – 0.55”, (6) Ø 0.158” – 0.315”
MGS-460	(2) M20, (6) M16	(2) Ø 0.394” – 0.55”, (6) Ø 0.158” – 0.315”
MGS-450	(2) M20, (6) M16	(2) Ø 0.394” – 0.55”, (6) Ø 0.158” – 0.315”
MGS-410	(4) M16	(4) Ø 0.158” – 0.315”
MGS-250	(1) 0.50”, (1) 0.50” (Optional)	(1) Ø 0.25”
MGS-550	(1) M20, (6) M16	(1) Ø 0.394” – 0.55”, (6) Ø 0.158” – 0.315”

3.2 Wire Terminations

For installation flexibility, the MGS-400 series Gas Detection Controllers and Gas Detectors include **B(-), A(+), Ground (GND),** and **Shield (SH)** Modbus Terminals. The MGS-250 does not include a GND terminal and the MGS-500 does not include a SH terminal.

Communication cabling is terminated as follows:

COMMUNICATION CABLE	MGS-400				MGS-250				MGS-550			
	A	B	GND	SH	A	B	GND	SH	A	B	GND	SH
A-WIRE	X				X				X			
B-WIRE		X				X				X		
GND WIRE			X					X			X	
SH WIRE			2	X			2	1			2	1

1: The SH wire is connected to the SH wire of the cable going to the next detector. If the detector is the last/only detector, leave the SH wire unterminated at the detector.

2: If the application or cabling does not include a GND wire, but includes a SH wire, please terminate the SH wire to the GND terminal of the controller/detector(s) (SH terminal on MGS-250 detectors). A GND wire is recommended, but not required unless local laws, codes, and standards dictate otherwise.

3.3 Cable Recommendations

GENERAL PURPOSE	PLENUM	CONDUCTORS				SHEILD	IMPEDENCE
		AWG	NO. OF CONDUCTORS	TOTAL	GROUND		
BELDEN 1392A[1,2,3] Ø0.25" (Ø6.35mm)	BELDEN 1392P[1,2,3] Ø0.205" (Ø5.207mm)	22	2 TP	4		24AWG DW	100 Ω[5]
		18	2				
BELDEN 1502R[1,2,3] Ø0.25" (Ø6.35mm)	BELDEN 1502P[1,2,3] Ø0.205" (Ø5.207mm)	22	2 TP	4		24AWG DW	100 Ω[5]
		18	2				
BELDEN 3106A[1,2,4] Ø0.30" (Ø7.62mm)		22	2 TP	2	1	22AWG DW	120 Ω

TP: Twisted Pair, DW: Drainwire
[1]Consult local codes or AHJ as required
[2]Or Equivalent
[3]Dual Power/Communications Cable
[4]Communications Only Cable
[5]120Ω impedance is recommended for all MGS units, 100Ω impedance is acceptable when using these cables

3.4 Single Cable Application

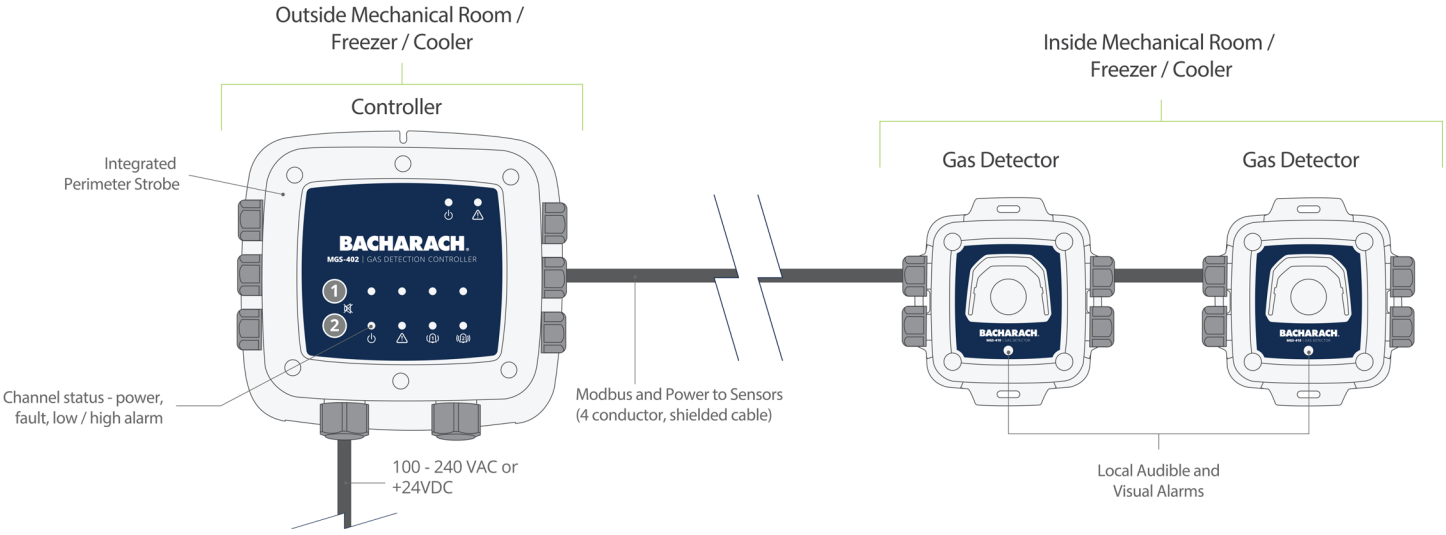

Figure 9. Single Cable Application

In this application, we will confirm whether the Belden 1392A or 1590R 4-core, single cable will suffice and the max distance the furthest Detector can be from the Controller.

This application consists of (1) MGS-402 Controller and (2) MGS-410 Detectors.

Using Section 2.1, the Total Detector Load of this application is determined to be 8 W. When cross referencing the table in Figure 8, an 8 W Total Detector Load intersects with the 18AWG wire column resulting in a max wire length of 861 FT. In conclusion, as long as the further MGS-410 Detector in this application does not exceed a wire length of 861 FT, the recommended Belden cables can be used.