HGM series
parallel controller
application collection

SMARTGEN (ZHENGZHOU) TECHNOLOGY CO.,LTD.

CONTENTS

Chinese trademark

English trademark

SmartGen — make your generator ***smart***

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Table 1 Software Version

Date	Version	Note
2021-03-18	1.0	Original release.

Table 2 Symbol Instruction

Symbol	Instruction
NOTE	Highlights an essential element of a procedure to ensure correctness.
CAUTION	Indicates a procedure or practice, which, if not strictly observed, could result in damage or destruction of equipment.
WARNING	Indicates a procedure or practice, which could result in injury to personnel or loss of life if not followed correctly.

Preface

With the development of genset control technology and the continuous improvement of field application requirements, the application of multi-set parallel connection and grid connection is becoming more and more normalized, diversified and complicated.

Smartgen parallel controller has been used for more than ten years, and has accumulated rich experience by solving on-site problems of various applications. In order to facilitate communication and sharing with users and peers, General Manager Cui Wenfeng of Smartgen Technology proposed to organize some of the data accumulated in our daily work into a book and present it to everyone.

This book has made a detailed introduction to multi-set "island parallel connection", "Mains peak lopping", "AMF mode" and high voltage parallel connection.

There may be some description errors in this book. Experts are welcome to correct them so that we can modify them in time. The book will be updated continuously according to your raised questions and expanded applications of the products, and your valuable suggestions are highly appreciated.

The parallel controllers in all the examples are Smartgen products, so this book can also be used as a reference book for the products.

This book is suitable for OEM manufacturers, genset rental company, special applications and other related genset operators who have an electrical foundation.

This book introduces various parallel schemes involved in the current power generation industry in detail and it is divided into five parts:

——Parallel scheme: including case introduction, corresponding parallel application method, how to set up, and realized functions.

——Parameter settings: including detailed descriptions of specific settings for different parallel modes.

——Debugging guide: including precautions before debugging, preparations, debugging steps, problem analysis, etc.

——GOV/AVR/ECU settings: including the GOV wiring application diagram, the AVR wiring application diagram, and the ECU wiring application diagram.

——Summarize: Summary about all related products covered in this book.

"Book in hand, plan in mind" is the value embodiment of this book, and "self-taught without a teacher make progress together" is the ultimate goal of writing this book.

This book was compiled and compiled by Zhou Zhitian, a product application engineer of Smartgen Technology. The people who participated in the compilation are: Cui Wenfeng, Wang Xiangqian, Wang Lei, Song Yaojun, Yao Guanbao, Gao Songwei, Zhang Zhibing and Wang Man, etc. Thank you for your contributions to this book.

Smartgen Technology is committed to the mission of "making control smarter"; its vision is to create a century of Smartgen and to be the most trusted brand of partners. Share the experience with users, and Smartgen Technology will make progress together with everyone and create brilliance together.

1 Parallel scheme

1.1 Start on demand applications

1.1.1 Parallel operation between two same power units

This solution is suitable for parallel applications where two gensets of same power are turned on as demand. The controller can choose HGM9510 or HGM9510N.

Applications include: factories, hospitals, supermarkets, etc.

Example 1: Two ECU units with rated power of 320kW and the AVR is SX440. One of the genset is powered on first, and then the other genset is started/stopped according to the load.

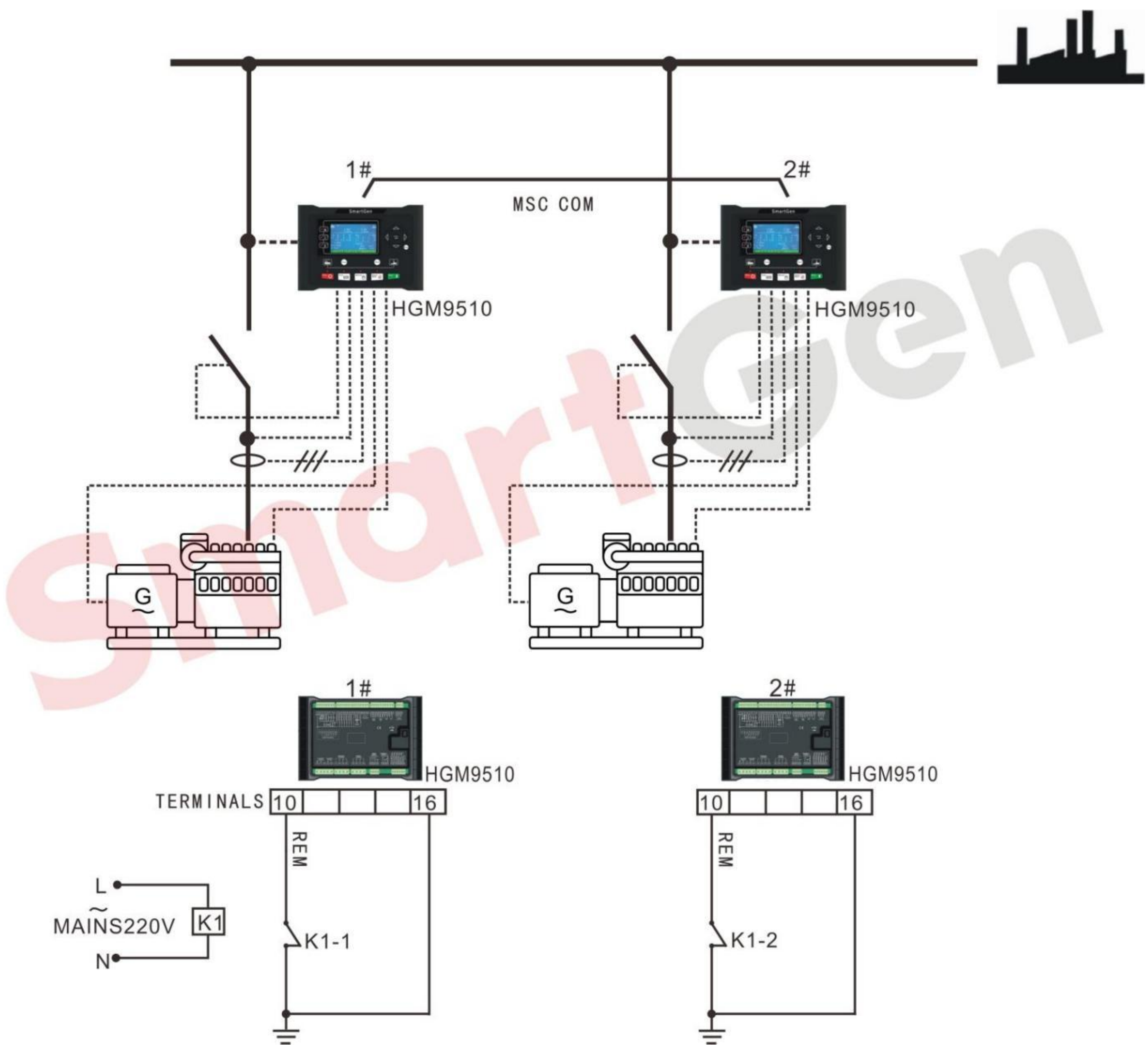


Fig. 1 Application diagram of two units with same power

Table 3 Parameter settings

<table>
<tr><th rowspan="2">Setting item</th><th rowspan="2">Setting parameters</th><th colspan="2">Settings</th><th rowspan="2">Remark</th></tr>
<tr><th>Unit 1</th><th>Unit 2</th></tr>
<tr><td rowspan="3">Engine Setting</td><td>Engine Type</td><td colspan="2">Refer to<Parameter Setting of EFI Unit></td><td></td></tr>
<tr><td>Rated speed</td><td colspan="2">1500r/min</td><td></td></tr>
<tr><td>Crank disconnect condition</td><td colspan="2">Gen frequency + speed</td><td></td></tr>
<tr><td rowspan="8">Generator Setting</td><td>AC power system</td><td colspan="2">3 Phase 4 Wire</td><td></td></tr>
<tr><td>Gen rated voltage (rated voltage)</td><td colspan="2">230V</td><td></td></tr>
<tr><td>Gen rated frequency (rated frequency)</td><td colspan="2">50Hz</td><td></td></tr>
<tr><td>Current transformer ratio</td><td colspan="2">600/5</td><td>Current transformer ratio＞ Full load rated current</td></tr>
<tr><td>Full load rated current (rated current)</td><td colspan="2">576A</td><td>Full load rated current =rated power ×1.8</td></tr>
<tr><td>Full load rated active power (rated active power)</td><td colspan="2">320kW</td><td></td></tr>
<tr><td>Full load rated reactive power (rated reactive power)</td><td colspan="2">240kvar</td><td>Set according to the power factor of 0.8</td></tr>
<tr><td rowspan="2">Input port setting</td><td>Digital input port 1</td><td colspan="2">Remote Start (on demand)</td><td></td></tr>
<tr><td>Digital input port 4</td><td colspan="2">Gen Close input</td><td></td></tr>
<tr><td rowspan="2">Output port settings</td><td>Digital output port 5</td><td colspan="2">Gen Open output</td><td></td></tr>
<tr><td>Digital output port 6</td><td colspan="2">Gen Close output</td><td></td></tr>
<tr><td rowspan="3">Sync settings</td><td>The number of multi-set communication</td><td colspan="2">2</td><td></td></tr>
<tr><td>Start options</td><td colspan="2">Start on demand</td><td></td></tr>
<tr><td>Scheduled on Load Percentage (Maximum load percentage at startup)</td><td colspan="2">80%</td><td>1. Scheduled on power = full-load active power of N units which currently connected in parallel × scheduled on load percentage</td></tr>
</table>

<table>
<tr><th rowspan="2">Setting item</th><th rowspan="2">Setting parameters</th><th colspan="2">Settings</th><th rowspan="2">Remark</th></tr>
<tr><th>Unit 1</th><th>Unit 2</th></tr>
<tr><td rowspan="2"></td><td></td><td colspan="2"></td><td>2. Scheduled on Load Percentage = Scheduled on power /full-load active power of N units which currently connected in parallel
Note: "N" indicates the number of paralleled units. In this example N=1.</td></tr>
<tr><td>Scheduled Stop Load Percentage (Minimum load percentage for stop)</td><td colspan="2">40%</td><td>1. Scheduled stop power = full-load active power of N units which currently connected in parallel × $\frac{(N-1)}{N}$ ×scheduled stop load percentage
2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in paralle× $\frac{N}{(N-1)}$
Note: "1" in the formula represents the unit with the lowest priority among the parallel units; "N" represents the number of parallel units. In this example N=2.
Note: Scheduled stop power refers to the load power.</td></tr>
<tr><td rowspan="3">Synchronized calibration</td><td>Multi-set communication (MSC) ID</td><td>1</td><td>2</td><td></td></tr>
<tr><td>Module run priority</td><td>1</td><td>2</td><td></td></tr>
<tr><td>GOV/AVR</td><td colspan="2">GOV: (SW1: 5; SW2: 2)</td><td>Refer to<HGM9500 Controller</td></tr>
</table>

<table>
<tr><th rowspan="2">Setting item</th><th rowspan="2">Setting parameters</th><th colspan="2">Settings</th><th rowspan="2">Remark</th></tr>
<tr><th>Unit 1</th><th>Unit 2</th></tr>
<tr><td></td><td></td><td colspan="2">AVR: (SW1: 0; SW2: 2)</td><td>GOV/AVR Parameters setting
></td></tr>
</table>

After the above parameter settings are completed, the controller is in auto mode, when the remote start input is active, unit 1 will start with load first, if the current load power is greater than the scheduled start power of 256kW, unit 2 will start in parallel, and the two units will share the current load power equally.

If the current load power is less than the scheduled stop power of 128kW, the load of unit 2 is transferred to unit 1, then unit 2 unloaded and stop, and unit 1 is loaded.

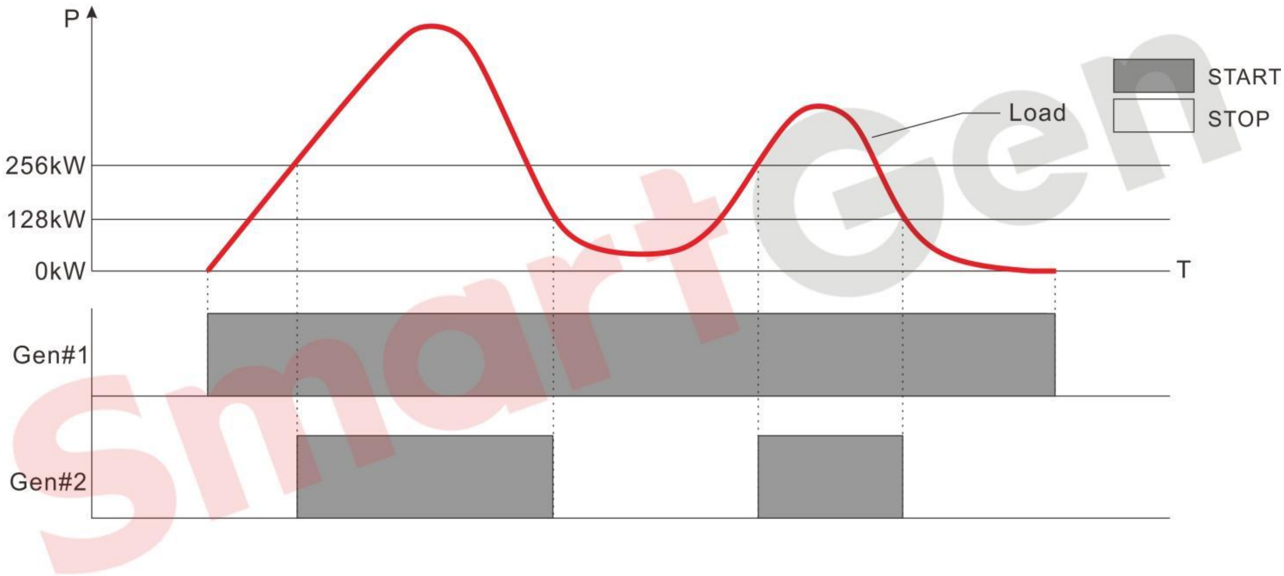


Fig. 2 Parallel start/stop curve of two units

1.1.2 Two units with different power in parallel

This solution is suitable for parallel application where two different power generator sets are turned on according to demand. HGM9510 or HGM9510N can be selected.

Example 2: Two non-ECU units combined with 500kW and 400kW which GOV is EFC3044196 and AVR is SX440, one of the genset is powered on first and loaded, then another unit will be start/stop according to the load.

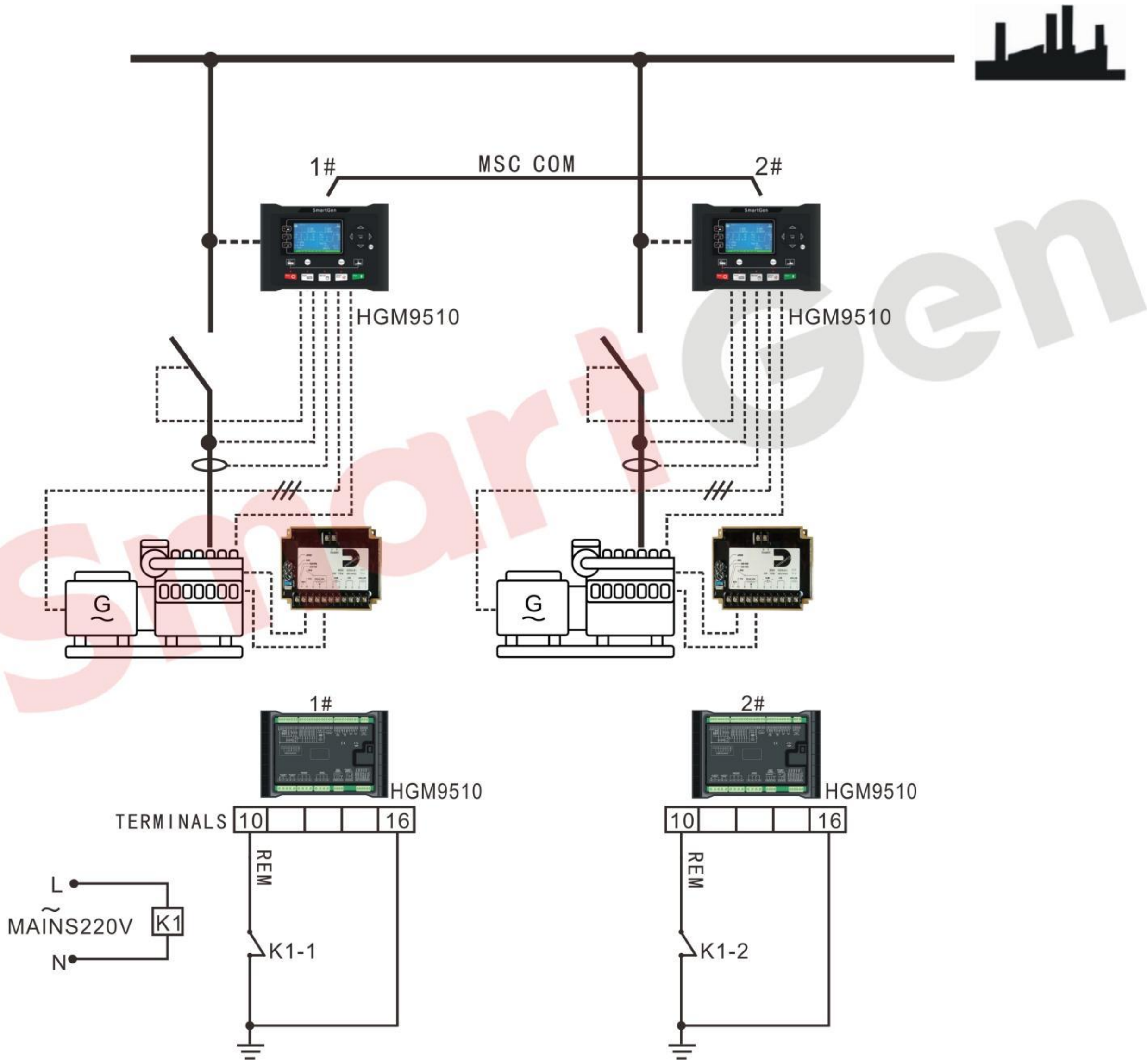


Fig. 3 Application diagram of two units with different power

Table 4 Related parameter settings

Setting item	Setting parameters	Settings		Remark
		Unit 1	Unit 2	
Engine Setting	Engine Type	Non ECU unit		
	Number of engine teeth	Set according to the result which caculated by the engine teeth formula.		Four-pole motor: $EngineTeeth=\left(\frac{Speed}{60}\times\frac{SetTeeth}{Frequency}\right)\times 2$ **Note: "60" means 60 seconds.**
	Rated speed	1500r/min		
	Crank disconnect	Gen frequency + speed		

Setting item	Setting parameters	Settings		Remark
		Unit 1	Unit 2	
	condition			
Generator Setting	AC power system	3 Phase 4 Wire		
	Gen rated voltage (rated voltage)	230V		
	Gen rated frequency (rated frequency)	50Hz		
	current transformer ratio	1000/5	800/5	Current transformer ratio＞ Full load rated current
	(rated current)	900A	720A	Full load rated current =rated power × 1.8
	(rated active power)	500kW	400kW	
	(rated reactive power)	380kvar	300kvar	Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)		
	Digital input port 4	Gen Close input		
Output port settings	Digital output port 5	Gen Open output		
	Digital output port 6	Gen Close output		
Sync settings	The number of multi-set communication	2		
	Start options	Start on demand		
	Scheduled on Load Percentage (Maximum load percentage at startup)	80%		1. Scheduled on power = full-load active power of N units which currently connected in parallel ×scheduled on load percentage 2. Scheduled on Load Percentage = Scheduled on power /full-load active power of N units which currently connected in parallel **Note: "N" indicates the number of paralleled units. In this example N=1.**
	Scheduled Stop Load Percentage	40%		1. Scheduled stop power = full-load active power of N units which currently

Setting item	Setting parameters	Settings		Remark
		Unit 1	Unit 2	
	(Minimum load percentage for stop)			connected in parallel× $\frac{(N-1)}{N}$ ×scheduled stop load percentage 2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in parallel× $\frac{N}{(N-1)}$ **Note: "1" in the formula represents the unit with the lowest priority to be stopped among the parallel units; "N" represents the number of parallel units. In this example N=2.** **Note: Scheduled stop power refers to the load power.**
Synchronized calibration	Multi-set communication (MSC) ID	1	2	
	Module run priority	1	2	
	GOV/AVR	GOV:(SW1: 5; SW2: 2)		Refer to <HGM9500 controller GOV/AVR parameter setting>
		AVR:(SW1: 0; SW2: 2)		

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, unit 1 will start with load first. If the total current load power is greater than 400kW, the unit 2 will be start and the two units will divide the current load equally.

If the current load power is less than the scheduled stop power of 180kW, the load of unit 2 is transferred to unit 1, then unit 2 unloaded and stop, and unit 1 is loaded.

Note: The "Scheduled start load percentage" and "Scheduled stop load percentage" of all units can be set as the same value or different values; when the power of the units is different, if change "Module Running Priority", it is recommended to reset the two percentages, otherwise the desired result may not be obtained.

1.1.3 Parallel connection of multi-sets with same power

This solution is suitable for parallel application where multiple sets with same power are turned on according to demand. HGM9510 or HGM9510N can be selected.

Example 3: Four ECU units combined with 300kW each which AVR is SX440, one of the genset is powered on first and loaded, then other 3 units will be start/stop according to the load.

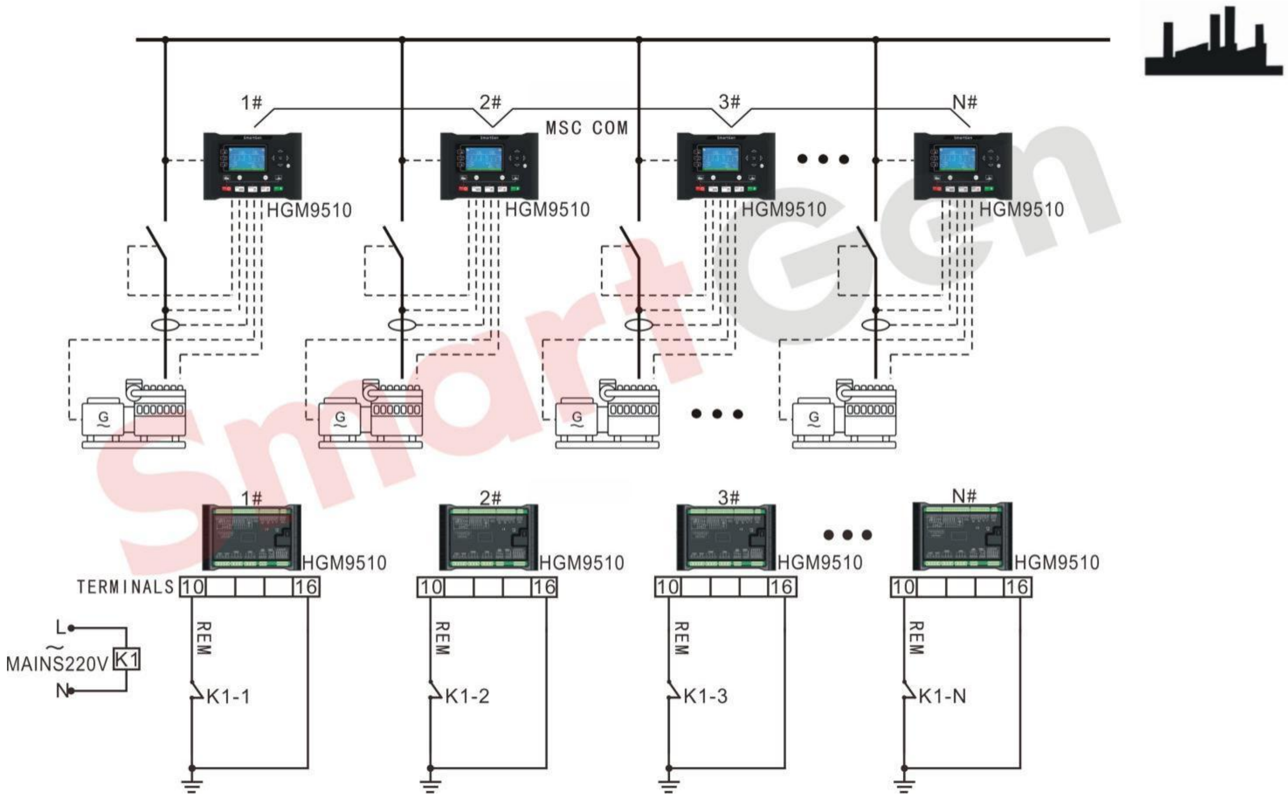


Fig. 4 Application diagram of multi-sets with same power

Table 5 Parameter settings of 4 gensets with same power

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>				
	Rated speed	1500r/min				
	Crank disconnect condition	Gen frequency + rotating speed				
Generator Setting	AC power system	3 Phase 4 Wire				
	Gen rated voltage (rated voltage)	230V				
	Gen rated frequency (rated frequency)	50Hz				
	current transformer ratio	600/5				Current transformer

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						ratio＞ Full load rated current
	Full load rated current (rated current)	540A				Full load rated current =rated power ×1.8
	Full load rated active power (rated active power)	300kW				
	Full load rated reactive power (rated reactive power)	228kvar				Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)				
	Digital input port 4	Gen Close input				
Output port settings	Digital output port 5	Gen Open output				
	Digital output port 6	Gen Close output				
Sync settings	The number of multi-set communication	4				
	Start options	Start on demand				
	Scheduled on Load Percentage (Maximum load percentage at startup)	80%				1. Scheduled on power = full-load active power of N units which currently connected in parallel × scheduled on load percentage 2. Scheduled on Load Percentage = Scheduled on power /full-load active power of N units which currently connected in parallel **Note: "N" indicates the number of paralleled units.** **In this example, N=1 when the second unit is scheduled on, N=2**

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						when the third unit is scheduled on, and N=3 when the fourth unit is scheduled on.
	Scheduled Stop Load Percentage (Minimum load percentage for stop)	40%				1. Scheduled stop power = full-load active power of N units which currently connected in parallel× $\frac{(N-1)}{N}$ ×scheduled stop load percentage 2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in parallel× $\frac{N}{(N-1)}$ **Note: "1" in the formula represents the unit with the lowest priority to be stopped among the parallel units; "N" represents the number of parallel units.** **In this example, N=4 when the fourth unit is scheduled stop, N=3 when the third unit is scheduled stop, and N=2 when the second unit is scheduled stop.** **Note: Scheduled**

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						stop power refers to the load power. **Note: When there are several parallel units, it is recommended to reduce the scheduled stop load percentage to avoid frequent start and stop of units.**
Synchronized calibration	Multi-set communication (MSC) ID	1	2	3	4	
	Module run priority	1	2	3	4	
	GOV/AVR	GOV: (SW1: 5; SW2: 2)				Refer to <HGM9500 controller GOV/AVR parameter setting>
		AVR: (SW1: 0; SW2: 2)				

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, unit 1 will start with load first. If the current load power is greater than 240kW, the unit 2 will be start and the two units will divide the current load equally. If the current load power is greater than 480kW, the unit 3 will be start and the three units will divide the current load equally. If the current load power is greater than 720kW, the unit 4 will be start and the four units will divide the current load equally.

If the current load power is less than 360kW, the unit 4 will be stopped and the three units will divide the current load equally. If the current load power is less than 240kW, the unit 3 will be stopped and the two units will divide the current load equally. If the current load power is less than 120kW, the unit 2 will be stopped and the unit 1 take load.

1.1.4 Multiple units with different power in parallel

This solution is suitable for parallel applications where multiple generator sets with different powers are turned on according to demand. HGM9510 or HGM9510N can be selected.

Example 4: There are four units which unit 1 and unit 2 are ECU units with 600kW of each while Unit 3 and Unit 4 are non-ECU units with 400kW of each. The GOV of non-ECU units is ESD5500 and the AVR

of 4 units are SX440, one of the genset is powered on first and loaded, then other 3 units will be start/stop according to the load.

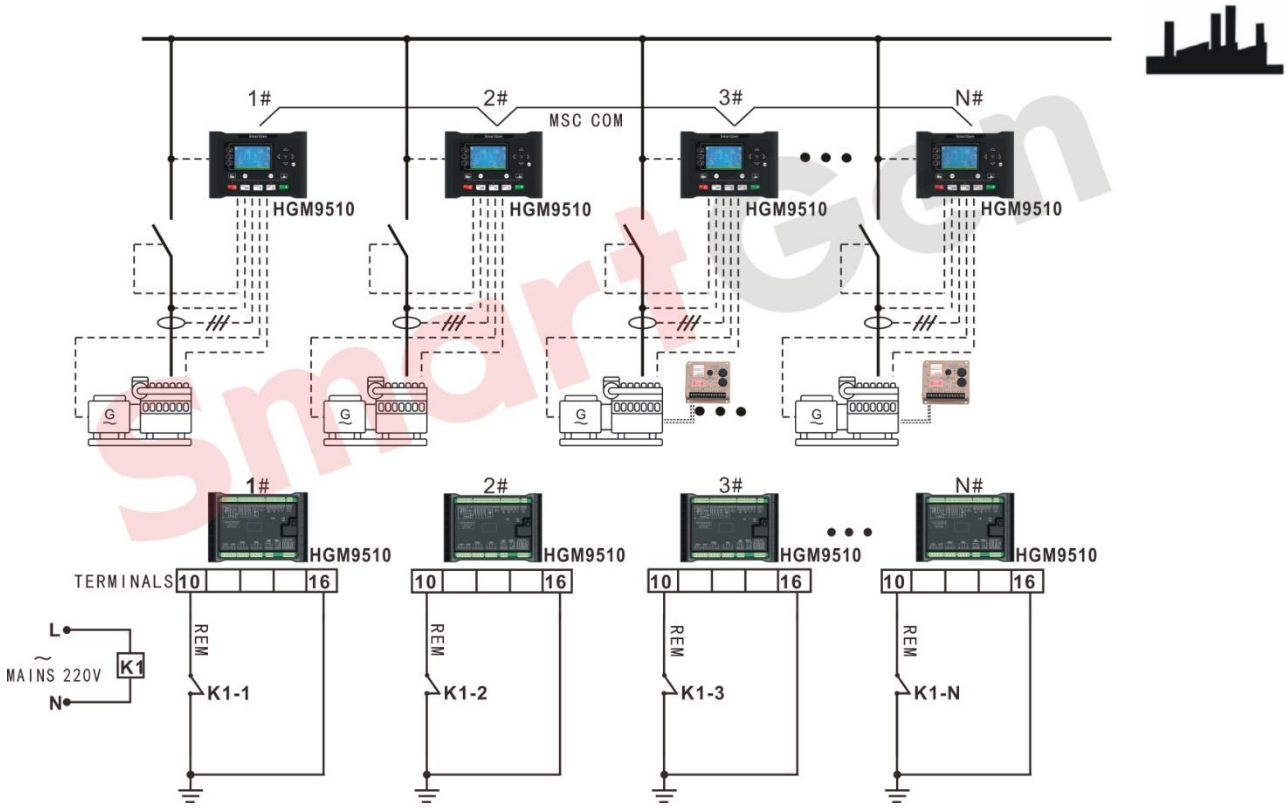


Fig. 5 Application diagram of multi-sets with different power

Table 6 Parameter settings of 4 gensets with different power

Setting item	**Setting parameters**	**Settings**				**Remark**
		Unit 1	**Unit 2**	**Unit 3**	**Unit 4**	
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>		Non ECU unit		
	Number of engine teeth			Set according to the result which caculated by the engine teeth formula.		Four-pole motor: $EngineTeeth = \left(\frac{Speed}{60} \times \frac{SetTeeth}{Frequency}\right) \times 2$ **Note: "60" means 60 seconds.**
	Rated speed	1500r/min				
	Crank disconnect condition	Gen frequency + rotating speed				

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
Generator Setting	AC power system	3 Phase 4 Wire				
	Gen rated voltage (rated voltage)	230V				
	Gen rated frequency (rated frequency)	50Hz				
	current transformer ratio	1200/5		750/5		Current transformer ratio＞ Full load rated current
	Full load rated current (rated current)	1080A		720A		Full load rated current =rated power×1.8
	Full load rated active power (rated active power)	600kW		400kW		
	Full load rated reactive power (rated active power)	450kvar		300kvar		Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)				
	Digital input port 4	Gen Close input				
Output port settings	Digital output port 5	Gen Open output				
	Digital output port 6	Gen Close output				
Sync settings	The number of multi-set communication	4				
	Start options	Start on demand				
	Scheduled on Load Percentage (Maximum load percentage at startup)	80%				1. Scheduled on power = full-load active power of N units which currently connected in parallel × scheduled on load percentage 2. Scheduled on Load Percentage = Scheduled on power /full-load active power of N units which currently connected in parallel **Note: "N" indicates the number of paralleled units.**

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						In this example, N=1 when the second unit is scheduled on, N=2 when the third unit is scheduled on, and N=3 when the fourth unit is scheduled on.
	Scheduled Stop Load Percentage (Minimum load percentage for stop)	40%				1. Scheduled stop power = full-load active power of N units which currently connected in parallel × $\frac{(N-1)}{N}$ ×scheduled stop load percentage 2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in parallel× $\frac{N}{(N-1)}$ **Note: "1" in the formula represents the unit with the lowest priority to be stopped among the parallel units; "N" represents the number of parallel units.** **In this example, N=4 when the fourth unit is scheduled stop, N=3 when the third unit is scheduled stop, and N=2 when the second unit is scheduled stop.** **Note: Scheduled stop power refers to the load power.** **Note: When there are**

<table>
<tr><th rowspan="2">Setting item</th><th rowspan="2">Setting parameters</th><th colspan="4">Settings</th><th rowspan="2">Remark</th></tr>
<tr><th>Unit 1</th><th>Unit 2</th><th>Unit 3</th><th>Unit 4</th></tr>
<tr><td></td><td></td><td colspan="4"></td><td>several parallel units, it is recommended to reduce the scheduled stop load percentage to avoid frequent start and stop of units.</td></tr>
<tr><td rowspan="4">Synchronized calibration</td><td>Multi-set communication (MSC) ID</td><td>1</td><td>2</td><td>3</td><td>4</td><td></td></tr>
<tr><td>Module run priority</td><td>1</td><td>2</td><td>3</td><td>4</td><td></td></tr>
<tr><td rowspan="2">GOV/AVR</td><td colspan="2">GOV: SW1: 5
SW2: 2</td><td colspan="2">GOV: SW1: 0
SW2: 2</td><td rowspan="2">Refer to <HGM9500 controller GOV/AVR parameter setting></td></tr>
<tr><td colspan="4">AVR: (SW1: 0; SW2: 2)</td></tr>
</table>

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, unit 1 will start with load first. If the current load power is greater than 480kW, the unit 2 will be start and the two units will divide the current load equally. If the current load power is greater than 960kW, the unit 3 will be start and the three units will divide the current load equally. If the current load power is greater than 1280kW, the unit 4 will be start and the four units will divide the current load equally.

If the current load power is less than 600kW, the unit 4 will be stopped and the three units will divide the current load equally. If the current load power is less than 427kW, the unit 3 will be stopped and the two units will divide the current load equally. If the current load power is less than 240kW, the unit 2 will be stopped and the unit 1 take load.

Note: The "Scheduled start load percentage" and "Scheduled stop load percentage" of all units can be set as the same value or different values; when the power of the units is different, if change "Module Running Priority", it is recommended to reset the two percentages, otherwise the desired result may not be obtained.

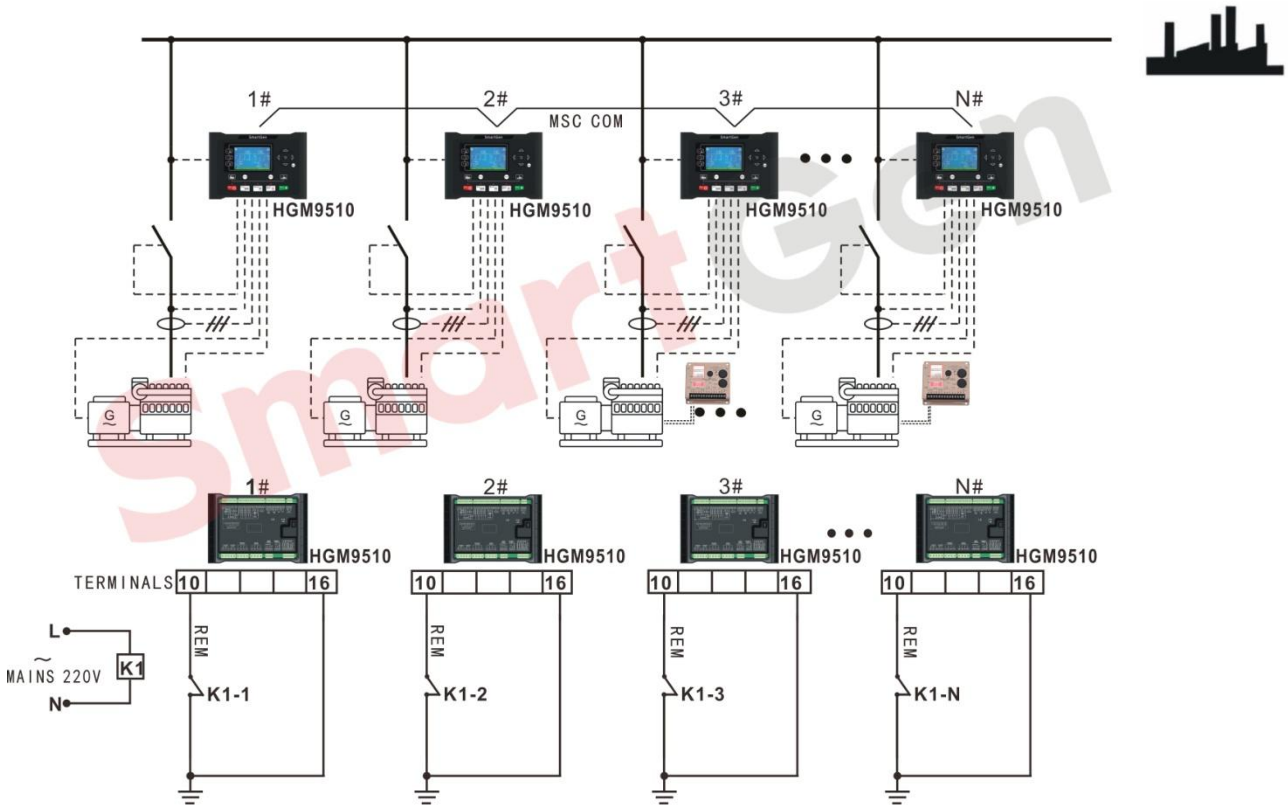
1.2 Full start application

1.2.1 Multi-set with same power in parallel connection at the same time

This solution is suitable for applications where multi-set with same power are powered on in parallel at the same time. According to the load demand, other units can be stopped/started reasonably, and HGM9510 or HGM9510N can be selected.

Applications include: factories with large loads, large supermarkets, etc.

Example 6: Four ECU units with rated power of 220kW are connected in parallel, and the AVR is SX440. Totally four units are required to loaded at the same time, and then stop/start three low-priority units according to the load demand. The unit with the highest priority keeps running at all time.



Tig. 6 Application diagram of multi-set with same power in parallel connection at the same time

Table 7 Parameter settings of 4 gensets with equal power

<table>
<tr><th rowspan="2">Setting item</th><th rowspan="2">Setting parameters</th><th colspan="4">Settings</th><th rowspan="2">Remark</th></tr>
<tr><th>Unit 1</th><th>Unit 2</th><th>Unit 3</th><th>Unit 4</th></tr>
<tr><td rowspan="3">Engine Setting</td><td>Engine Type</td><td colspan="4">Refer to<Parameter Setting of EFI Unit></td><td></td></tr>
<tr><td>Rated speed</td><td colspan="4">1500r/min</td><td></td></tr>
<tr><td>Crank disconnect condition</td><td colspan="4">Gen frequency + rotating speed</td><td></td></tr>
<tr><td rowspan="3">Generator Setting</td><td>AC power system</td><td colspan="4">3 Phase 4 Wire</td><td></td></tr>
<tr><td>Gen rated voltage (rated voltage)</td><td colspan="4">230V</td><td></td></tr>
<tr><td>Gen rated frequency (rated frequency)</td><td colspan="4">50Hz</td><td></td></tr>
</table>

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
	current transformer ratio	400/5				Current transformer ratio> Full load rated current
	Rated rated current	396A				Full load rated current =rated power ×1.8
	Full load rated active power (rated active power)	220kW				
	Full load rated reactive power (rated reactive power)	165kvar				Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)				
	Digital input port 4	Gen Close input				
Output port settings	Digital output port 5	Gen Open output				
	Digital output port 6	Gen Close output				
Sync settings	The number of multi-set communication	4				
	Start options	All power on				
	full start delay	180s				Four generator sets are started at the same time and connected in parallel. After 180s delay, the three generator sets with lower priority will be stopped according to the load.
	Scheduled on Load Percentage (Maximum load percentage at startup)	80%				1. Scheduled on power = full-load active power of N units which currently connected in parallel × scheduled on load percentage 2. Scheduled on Load Percentage = Scheduled on power /full-load active power of N units which currently connected in parallel **Note: "N" indicates the**

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						number of paralleled units. In this example, N=1 when the second unit is scheduled on, N=2 when the third unit is scheduled on, and N=3 when the fourth unit is scheduled on.
	Scheduled Stop Load Percentage (Minimum load percentage for stop)	40%				1. Scheduled stop power = full-load active power of N units which currently connected in parallel $\times \frac{(N-1)}{N} \times$ scheduled stop load percentage 2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in parallel $\times \frac{N}{(N-1)}$ **⚠ Note: "1" in the formula represents the unit with the lowest priority to be stopped among the parallel units; "N" represents the number of parallel units.** **In this example, N=4 when the fourth unit is scheduled stop, N=3 when the third unit is scheduled stop, and N=2 when the second unit is scheduled stop.** **⚠ Note: Scheduled stop power refers to the load power.** **⚠ Note: When there are**

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						several parallel units, it is recommended to reduce the scheduled stop load percentage to avoid frequent start and stop of units.
Synchronized calibration	Multi-set communication (MSC) ID	1	2	3	4	
	Module run priority	1	2	3	4	
	GOV/AVR	GOV: (SW1: 5; SW2: 2)				Refer to <HGM9500 controller GOV/AVR parameter setting>
		AVR: (SW1: 0; SW2: 2)				

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, the four units will be powered on at the same time and loaded in parallel. After a delay of 180 seconds, If the current load power is less than 264kW, the unit 4 will be stopped and the three units will divide the current load equally. If the current load power is less than 176kW, the unit 3 will be stopped and the two units will divide the current load equally. If the current load power is less than 88kW, the unit 2 will be stopped and the unit 1 take load.

If the load power is greater than 176kW, the unit 2 will be start and the two units will divide the load equally. If the load power is greater than 352kW, the unit 3 will be start and the three units will divide the load equally. If the load power is greater than 528kW, the unit 4 will be start and the four units will divide the load equally.

1.2.2 Two units with different power in parallel connection at the same time

This solution is suitable for applications where two units with same power are powered on in parallel at the same time. According to the load demand, other units can be stopped/started reasonably, and HGM9510 or HGM9510N can be selected.

Example 5: Two non-ECU units combined with 440kW and 640kW which GOV is ESD5500 and AVR is MX321. The two units start in parallel simultaneously, then another unit will be start/stop according to the load.

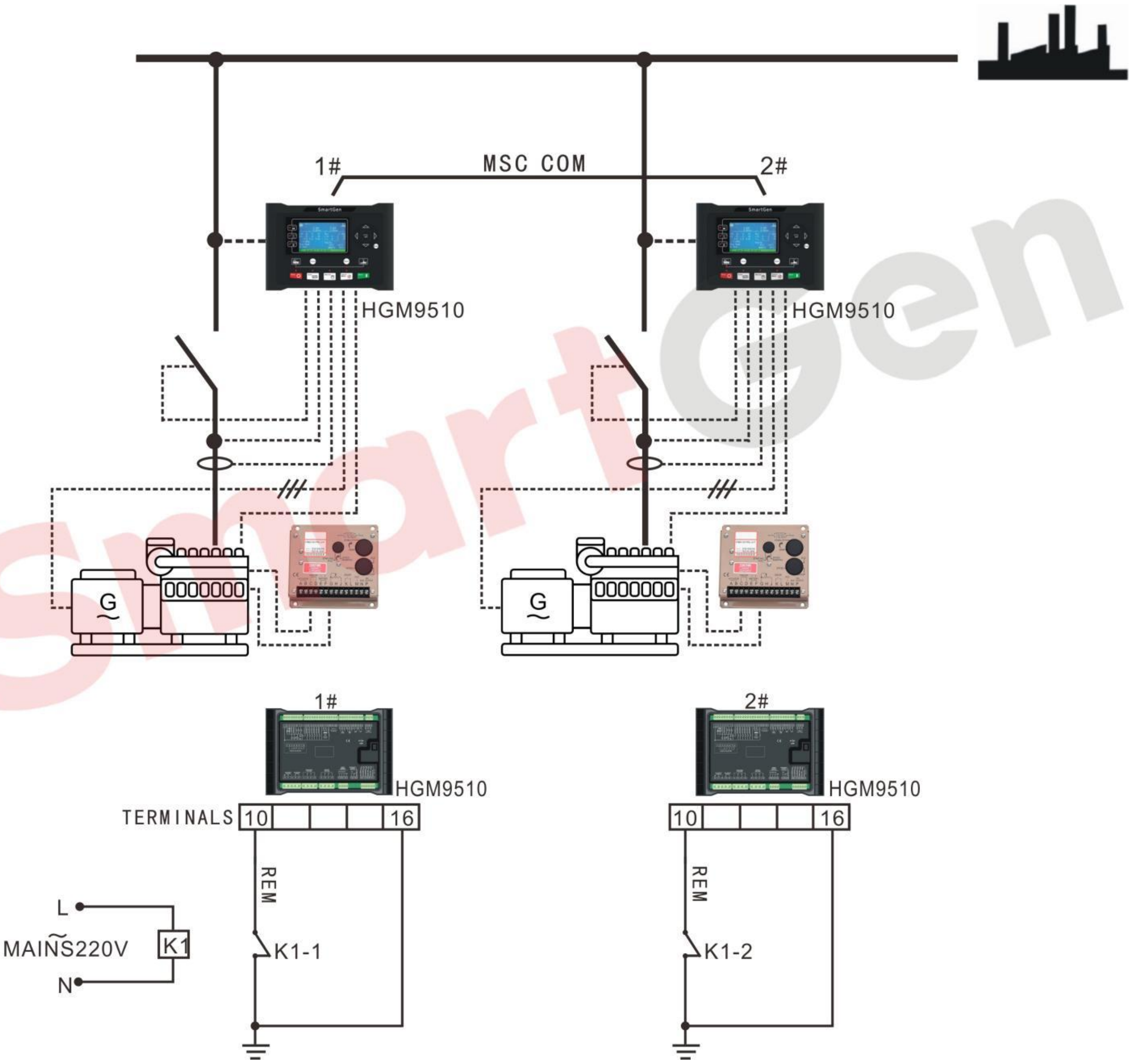


Fig. 7 Application diagram of two units with different power in parallel connection at the same time

Table 8 Parameter settings

Setting item	**Setting parameters**	**Settings**		**Remark**
		Unit 1	**Unit 2**	
Engine Setting	Engine Type	Non ECU unit		
	Number of engine teeth	Set according to the result which caculated by the engine teeth formula.		Four-pole motor: $Engine\ Teeth = \left(\frac{Speed}{60} \times \frac{SetTeeth}{Frequency}\right) \times 2$ **Note: "60" means 60 seconds.**
	Rated speed	1500r/min		
	Crank disconnect	Gen frequency +		

Setting item	Setting parameters	Settings		Remark
		Unit 1	Unit 2	
	condition	rotating speed		
Generator Setting	AC power system	3 Phase 4 Wire		
	Gen rated voltage (rated voltage)	230V		
	Gen rated frequency (rated frequency)	50Hz		
	current transformer ratio	800/5	1200/5	Current transformer ratio > Full load rated current
	Full load rated current (rated current)	792A	1152A	
	Full load rated active power (rated active power)	440kW	640KW	
	Full load rated reactive power (rated reactive power)	330kvar	480kvar	Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)		
	Digital input port 4	Gen Close input		
Output port settings	Digital output port 5	Gen Open output		
	Digital output port 6	Gen Close output		
Sync settings	The number of multi-set communication	2		
	Start options	All power on		
	full start delay	180s		Two generator sets are started at the same time and connected in parallel. After 180s delay, the other generator sets with lower priority will be stopped according to the load.
	Scheduled on Load Percentage (Maximum load percentage at startup)	80%		1. Scheduled on power = full-load active power of N units which currently connected in parallel × scheduled on load percentage 2. Scheduled on Load Percentage = Scheduled on power /full-load active

Setting item	Setting parameters	Settings		Remark
		Unit 1	Unit 2	
				power of N units which currently connected in parallel **Note: "N" indicates the number of paralleled units.** **In this example N=1**
	Scheduled Stop Load Percentage (Minimum load percentage for stop)	40%		1. Scheduled stop power = full-load active power of N units which currently connected in parallel × $\frac{(N-1)}{N}$ ×scheduled stop load percentage 2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in parallel× $\frac{N}{(N-1)}$ **Note: "1" in the formula represents the unit with the lowest priority to be stopped among the parallel units; "N" represents the number of parallel units.** **In this example N=2** **Note: Scheduled stop power refers to the load power.**
Synchronized calibration	Multi-set communication (MSC) ID	1	2	
	Module run priority	1	2	
	GOV/AVR	GOV:(SW1: 9; SW2: 2) AVR:(SW1: 0; SW2: 2)		Refer to <HGM9500 controller GOV/AVR parameter setting>

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, the two units will be powered on at the same time and loaded in parallel. After a delay of 180 seconds, If the load power is less than 216kW, the unit 2 will be stopped and the unit 1 take load. If the load

power is greater than 352kW, the unit 2 will be start and parallel with unit 1, and the two units will divide the load equally.

1.2.3 Fast parallel connection of multi-set (static parallel connection)

This solution is suitable for fast parallel connection of multi-set. HGM9510N controller is advised.

Note: The "static parallel connection" function can be selected via a digital input port.

Disconnect all generator excitation and close all generator power supply (generator power supply must select DC control) before start the genset, and then start all generator at the same time. When the speed of all engines reaches the load speed, close the excitation switch and the generator establish the voltage at the same time, and then the parallel connection is completed.

Compared with common parallel connection, the delay for the unit to wait for the synchronization conditions to be met was saved. When the unit fails to meet the output excitation requirments within the set static parallel delay, the unit will exit the static parallel mode and enter into normal parallel mode. The generator open and excitation output, and it will close and parallel again after the synchronization requirments are met.

Example 7: Four ECU units combined with 400kW each which AVR is DVR2000. All four units need to be start in parallel and output to the transformer, and then other 3 units will be start/stop according to the load.

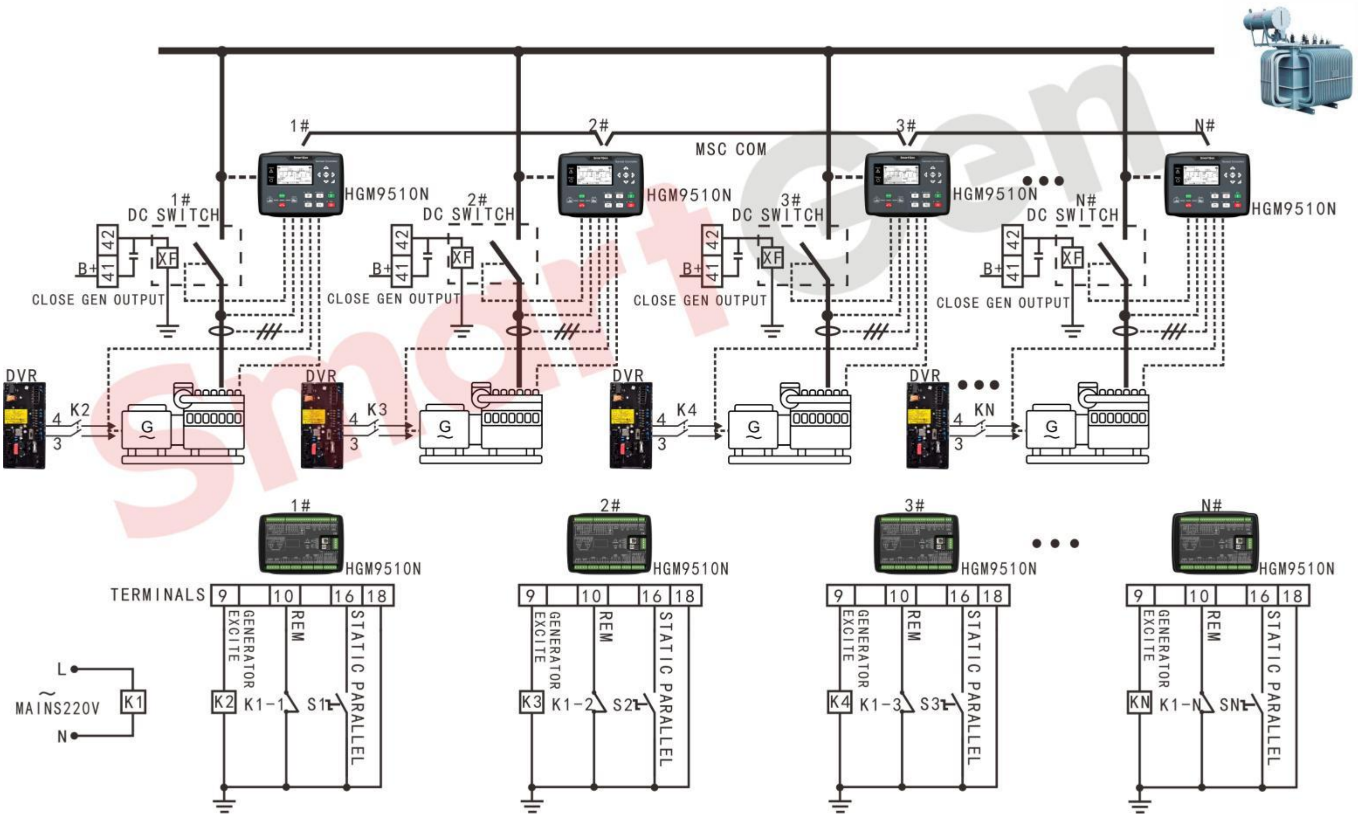


Fig. 8 Application diagram of multi-set with same power in fast parallel connection

Table 9 Parameter settings of four units with same power in fast parallel connection

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>				
	Rated speed	1500r/min				
	Crank disconnect condition	Gen frequency + rotating speed				
Generator Setting	AC power system	3 Phase 4 Wire				
	Gen rated voltage (rated voltage)	230V				
	Gen rated frequency (rated frequency)	50Hz				
	current transformer ratio	800/5				Current transformer ratio＞ Full load rated current
	Full load rated	720A				Full load rated current =rated

<table>
<tr><th rowspan="2">Setting item</th><th rowspan="2">Setting parameters</th><th colspan="4">Settings</th><th rowspan="2">Remark</th></tr>
<tr><th>Unit 1</th><th>Unit 2</th><th>Unit 3</th><th>Unit 4</th></tr>
<tr><td rowspan="3"></td><td>current
(rated current)</td><td colspan="4"></td><td>power ×1.8</td></tr>
<tr><td>Full load rated active power
(rated active power)</td><td colspan="4">400kW</td><td></td></tr>
<tr><td>Full load rated reactive power
(rated reactive power)</td><td colspan="4">300kvar</td><td>Set according to the power factor of 0.8</td></tr>
<tr><td rowspan="3">Input port setting</td><td>Digital input port 1</td><td colspan="4">Remote Start (on demand)</td><td></td></tr>
<tr><td>Digital input port 4</td><td colspan="4">Gen Close input</td><td></td></tr>
<tr><td>Digital input port 5</td><td colspan="4">Static Parallel Mode</td><td>must be active always</td></tr>
<tr><td rowspan="3">Output port settings</td><td>Digital output port 5</td><td colspan="4">Gen Open output</td><td></td></tr>
<tr><td>Digital output port 6</td><td colspan="4">Gen Close output</td><td></td></tr>
<tr><td>Digital output port 7</td><td colspan="4">Generator magnetizing output</td><td>Generator Excitation Control</td></tr>
<tr><td rowspan="5">Sync settings</td><td>The number of multi-set communication</td><td colspan="4">4</td><td></td></tr>
<tr><td>Start options</td><td colspan="4">All power on</td><td></td></tr>
<tr><td>Number of online units</td><td colspan="4">1</td><td></td></tr>
<tr><td>full start delay</td><td colspan="4">180s</td><td>Four generator sets are started at the same time and connected in parallel statically. After 180s delay, the three generator sets with lower priority will be stopped according to the load.</td></tr>
<tr><td>Static parallel delay</td><td colspan="4">60s</td><td>When the unit fails to meet the output excitation requirments within the set static parallel delay, the unit will exit the static parallel mode and enter into normal parallel mode. The generator open and excitation</td></tr>
</table>

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						output, and it will close and parallel again after the synchronization requirments are met.
	Scheduled on Load Percentage (Maximum load percentage at startup)	80%				1. Scheduled on power = full-load active power of N units which currently connected in parallel * scheduled on load percentage 2. Scheduled on Load Percentage = Scheduled on power /full-load active power of N units which currently connected in parallel ⚠ **Note: "N" indicates the number of paralleled units. In this example, N=1 when the second unit is scheduled on, N=2 when the third unit is scheduled on, and N=3 when the fourth unit is scheduled on.**
	Scheduled Stop Load Percentage (Minimum load percentage for stop)	40%				1. Scheduled stop power = full-load active power of N units which currently connected in parallel $\times \frac{(N-1)}{N} \times$ scheduled stop load percentage 2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in parallel $\times \frac{N}{(N-1)}$

<table>
<tr><th rowspan="2">Setting item</th><th rowspan="2">Setting parameters</th><th colspan="4">Settings</th><th rowspan="2">Remark</th></tr>
<tr><th>Unit 1</th><th>Unit 2</th><th>Unit 3</th><th>Unit 4</th></tr>
<tr><td></td><td></td><td colspan="4"></td><td>⚠Note: "1" in the formula represents the unit with the lowest priority to be stopped among the parallel units; "N" represents the number of parallel units.
In this example, N=4 when the fourth unit is scheduled stop, N=3 when the third unit is scheduled stop, and N=2 when the second unit is scheduled stop.
⚠Note: Scheduled stop power refers to the load power.
⚠Note: When there are several parallel units, it is recommended to reduce the scheduled stop load percentage to avoid frequent start and stop of units.</td></tr>
<tr><td rowspan="3">Synchronized calibration</td><td>Multi-set communication (MSC) ID</td><td>1</td><td>2</td><td>3</td><td>4</td><td></td></tr>
<tr><td>Module run priority</td><td>1</td><td>2</td><td>3</td><td>4</td><td></td></tr>
<tr><td>GOV/AVR</td><td colspan="4">GOV: (SW1: 5; SW2: 2)
AVR: (SW1: 0; SW2: 2)</td><td>Refer to <HGM9500N controller GOV/AVR parameter setting></td></tr>
</table>

If all above parameter settings are completed and the controller is in auto mode, when static parallel mode and remote start input are both active, all Gen power closed and then four units start simultaneously. When the speed of all engines reaches the load speed, close the excitation switch and the generator establish the voltage at the same time. If the current load power is less than 480kW, the unit 4 will be stopped and the three units will divide the current load equally. If the current load power is less than 320kW, the unit 3 will be stopped

and the two units will divide the current load equally. If the current load power is less than 160kW, the unit 2 will be stopped and the unit 1 take load.

If the load power is greater than 320kW, the unit 2 will be start and parallel with BUS, and the two units will divide the load equally. If the load power is greater than 640kW, the unit 3 will be start and parallel with BUS, and the three units will divide the load equally. If the load power is greater than 960kW, the unit 4 will be start and parallel with BUS, and the four units will divide the load equally.

1.3 Balanced runtime applications

1.3.1 Application Notes for Balanced Runtime

Balance the operating time of all generators so that all units' run time are same. Benefit from this, all the generators can be maintained at one time and the life of the whole generators can be extended. You can choose HGM9510 or HGM9510N controller, while HGM9510N is advised due to its more flexible and more powerful function.

1.3.2 Parallel connection with two same/different power unit

This solution is suitable for parallel applications where two gensets with different power are running according to balanced runtime. HGM9510N can be selected.

Example 8: Two ECU units combined with 580kW and 460kW which AVR is MX321. Before balanced, the accumulative runtime of unit 1 is 190 hours, and that of unit 2 is 170 hours. Unit 2 is started first and unit 1 is started in parallel with unit 2 when the two units have the same runtime, following that unit 2 is soft-unloaded and stopped. The two units are started in a cycle according to the set balanced runtime.

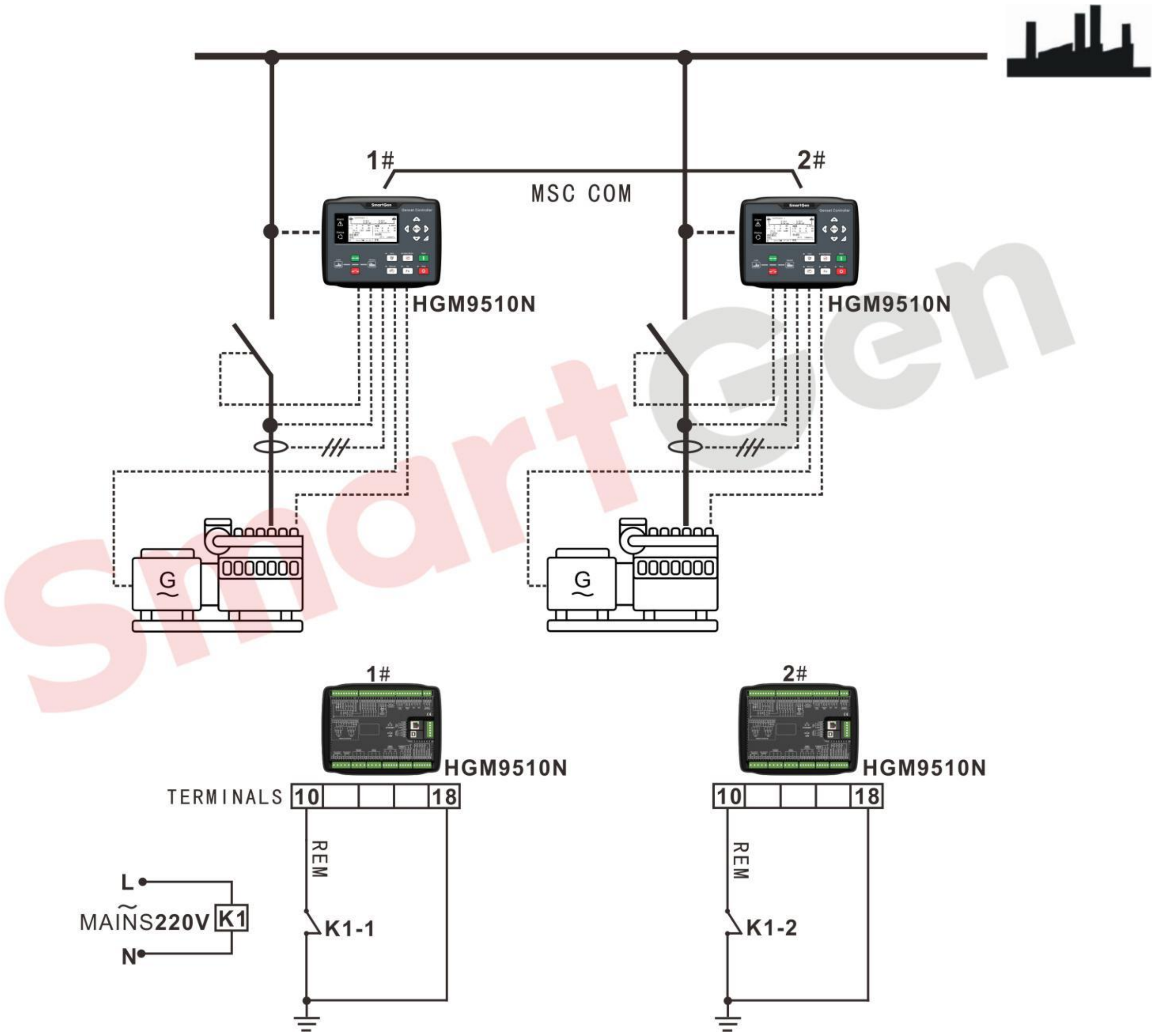


Fig. 9 Application diagram of balanced runtime parallel of two units with different power

Table 10 Related parameter settings

Setting item	Setting parameters	Settings		Remark
		Unit 1	Unit 2	
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>		
	Rated speed	1500r/min		
	Crank disconnect condition	Gen frequency + rotating speed		
Generator Setting	AC power system	3 Phase 4 Wire		
	Gen rated voltage (rated voltage)	230V		

Setting item	Setting parameters	Settings		Remark
		Unit 1	Unit 2	
	Gen rated frequency (rated frequency)	50Hz		
	current transformer ratio	1200/5	1000/5	Current transformer ratio＞ Full load rated current
	Full load rated current (rated current)	1044A	828A	Full load rated current =rated power × 1.8
	Full load rated active power (rated active power)	580kW	460kW	
	Full load rated reactive power (rated reactive power)	440kvar	340kvar	Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)		
	Digital input port 4	Gen Close input		
Output port settings	Digital output port 5	Gen Open output		
	Digital output port 6	Gen Close output		
Sync settings	The number of multi-set communication	2		
	Start options	Start on demand		
	Balanced runtime	20h		Switch the units when the accumulated running time difference of two units is 20 hours. The number of online units refers to the minimum number of units which running in parallel at the same time. In this example, if it is set to 2, the two units will always run at the same time.
	Number of online units	1		
	Scheduled on Load Percentage (Maximum load percentage at startup)	80%		1. Scheduled on power = full-load active power of N units which currently connected in parallel × scheduled on load percentage 2. Scheduled on Load Percentage = Scheduled on power /full-load active

<table>
<tr><th rowspan="2">Setting item</th><th rowspan="2">Setting parameters</th><th colspan="2">Settings</th><th rowspan="2">Remark</th></tr>
<tr><th>Unit 1</th><th>Unit 2</th></tr>
<tr><td rowspan="2"></td><td></td><td colspan="2"></td><td>power of N units which currently connected in parallel
Note: "N" indicates the number of paralleled units.
In this example N=1</td></tr>
<tr><td>Scheduled Stop Load Percentage (Minimum load percentage for stop)</td><td colspan="2">40%</td><td>1. Scheduled stop power = full-load active power of N units which currently connected in parallel × $\frac{(N-1)}{N}$ ×scheduled stop load percentage
2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in parallel× $\frac{N}{(N-1)}$
Note: "1" in the formula represents the unit with the lowest priority to be stopped among the parallel units; "N" represents the number of parallel units.
In this example N=2
Note: Scheduled stop power refers to the load power.</td></tr>
<tr><td rowspan="2">Synchronized calibration</td><td>Multi-set communication (MSC) ID</td><td>1</td><td>2</td><td>If the “balanced runtime function is enabled, the unit with less runtime has higher priority than the one with more runtime. Otherwise, the unit with smaller module ID has higher priority than the one with larger module ID. The runtime refers to the user's accumulated runtime B.</td></tr>
<tr><td>Module run priority</td><td colspan="2">1</td><td>If balanced runtime function is enabled, all units that need to balance the runtime should be set as same</td></tr>
</table>

Setting item	Setting parameters	Settings		Remark
		Unit 1	Unit 2	
				priority. The unit with less runtime has higher priority while the one with less MSC ID has higher priority if the runtime is same. Note: HGM9510 cannot be set as the same priority.
	GOV/AVR	GOV: SW1: 5; SW2: 2 AVR: SW1: 0; SW2: 2		Refer to <HGM9500N controller GOV/AVR parameter setting>

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, the unit 2 with less accumulated runtime will start first to take load. When the accumulated runtime of unit 2 reaches 190 hours, unit 1 is start and parallel with unit 2, and then unit 2 is unloaded and stopped.The two gensets start/stop circularly automatically according to the set balanced engine runtime of 20 hours (The one with less runtime and smaller module ID has higher priority).

During balanced runtime, if the load power is greater than the scheduled start percentage set value of the running unit, the other unit will start and take load in parallel; if the load power is less than the scheduled stop percentage, the unit with less runtime will be unloaded and stopped. The two gensets start/stop circularly automatically according to the set balanced engine runtime of 20 hours (The one with less runtime and smaller module ID has higher priority).

1.3.3 Multisets in parallel with the same power

This solution is suitable for parallel applications where multiple gensets with same power are running according to balanced runtime. HGM9510N can be selected and multi-sets can be balanced in group.

Example 9: Four ECU units combined with 520kW each which AVR is MX321.The cumulative runtime of unit 1 is 20 hours, and that of unit 2 is 30 hours whle unit 3 is 40 hours and unit 4 is 55 hours. Then, the runtime of the four units can be balanced alternately from less to more according to the accumulative runtime.

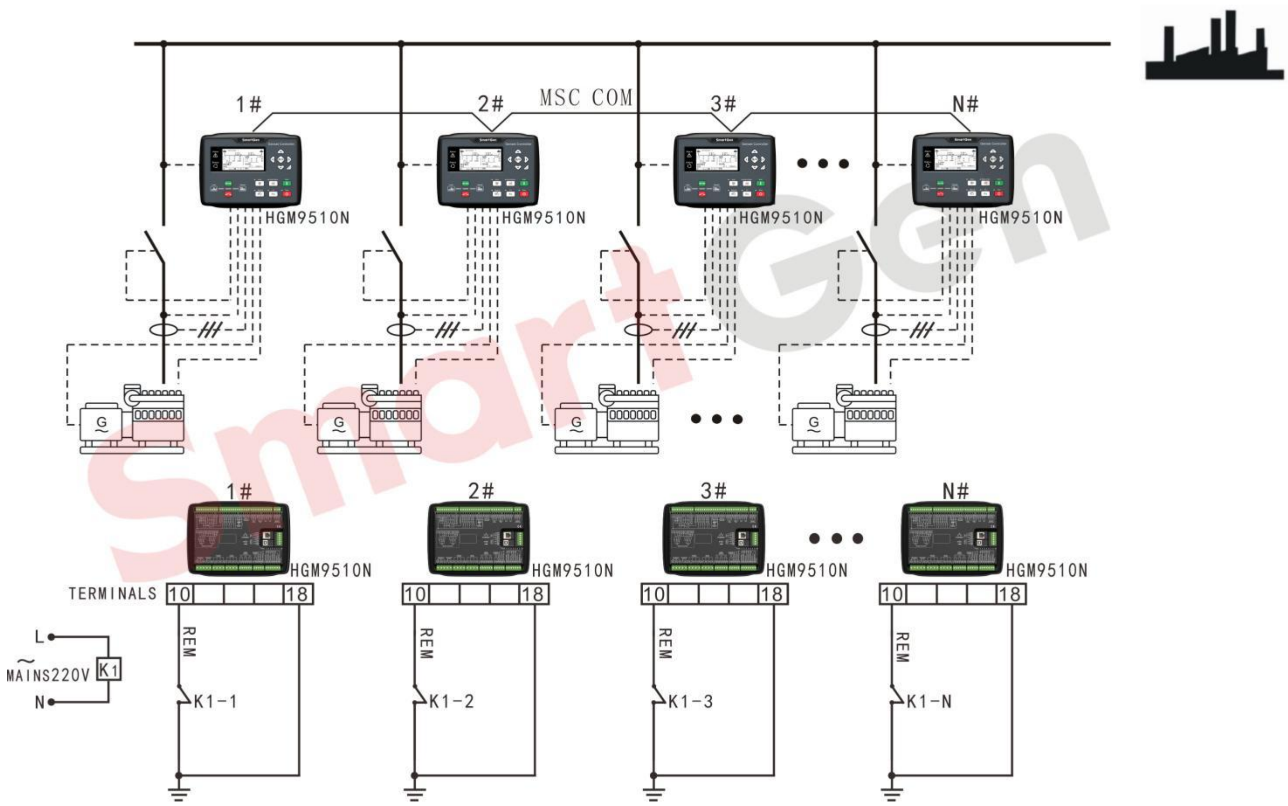


Fig. 10 Application diagram of balanced runtime parallel of multi-set with same power

Table 11 Parameter settings of balanced runtime parallel of four units with same power

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>				
	Rated speed	1500r/min				
	Crank disconnect condition	Gen frequency + rotating speed				
Generator Setting	AC power system	3 Phase 4 Wire				
	Gen rated voltage (rated voltage)	230V				
	Gen rated frequency (rated frequency)	50Hz				
	current transformer ratio	1000/5				
	Full load rated current (rated current)	936A				
	Full load rated active	520kW				

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
	power (rated active power)					
	Full load rated reactive power (rated reactive power)	390kvar				Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)				
	Digital input port 4	Gen Close input				
Output port settings	Digital output port 5	Gen Open output				
	Digital output port 6	Gen Close output				
Sync settings	The number of multi-set communication	4				
	Start options	Start on demand				
	Balanced runtime	10h				
	Number of online units	2				The number of online units refers to the minimum number of units which running in parallel at the same time. In this example, if it is set to 2, the two units will always run at the same time.
	Scheduled on Load Percentage (Maximum load percentage at startup)	80%				1. Scheduled on power = full-load active power of N units which currently connected in parallel × scheduled on load percentage 2. Scheduled on Load Percentage = Scheduled on power /full-load active power of N units which currently connected in parallel ⚠ **Note: "N" indicates the number of paralleled units. In this example, N=1 when the second unit is scheduled on, N=2 when the third unit is**

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						scheduled on, and N=3 when the fourth unit is scheduled on.
	Scheduled Stop Load Percentage (Minimum load percentage for stop)	40%				1. Scheduled stop power = full-load active power of N units which currently connected in parallel × $\frac{(N-1)}{N}$ ×scheduled stop load percentage 2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in parallel× $\frac{N}{(N-1)}$ **⚠ Note: "1" in the formula represents the unit with the lowest priority to be stopped among the parallel units; "N" represents the number of parallel units.** **⚠ Note: Scheduled stop power refers to the load power.**
Synchronized calibration	Multi-set communication (MSC) ID	1	2	3	4	If balanced runtime function is enabled, all units that need to balance the runtime should be set as same priority. The unit with less runtime has higher priority while the one with less MSC ID has higher priority if the runtime is same. Note: HGM9510 cannot be set as the same priority.
	Module run priority	1	2	3	4	

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
	GOV/AVR	GOV: (SW1: 5; SW2: 2) AVR: (SW1: 0; SW2: 2)				Refer to <HGM9500N controller GOV/AVR parameter setting>

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, unit 1 and unit 2 are scheduled start and stop according to the load power. Only when the load power is greater than the set value of scheduled start percentage, unit 3 will start first (generator with less accumulated runtime). When the accumulated runtime of unit 3 reaches 55 hours, unit 4 will be started and parallel, and then unit 3 unloaded and stopped. As long as the load power is greater than the set value of scheduled start percentage of units 1 and 2, unit 3 and 4 will start/stop circularly automatically, that is, only the unit 3 and unit 4 balance the runtime while unit 1 and 2 will not participate.

1.4 Application of Genet/mains parallel connection

1.4.1 Gen control mode (constant power mode)

This solution is suitable for a genset parallel with mains, and the genset is mainly on-load. HGM9510 and HGM9510N controllers can be selected. The applications include: biogas power generation, landfill gas power generation and gas power generation, etc.

Example 12: An ECU unit with a rated power of 680kW, and the AVR is MX321. The unit is parallel with mains, and the HGM9510 controller is selected.

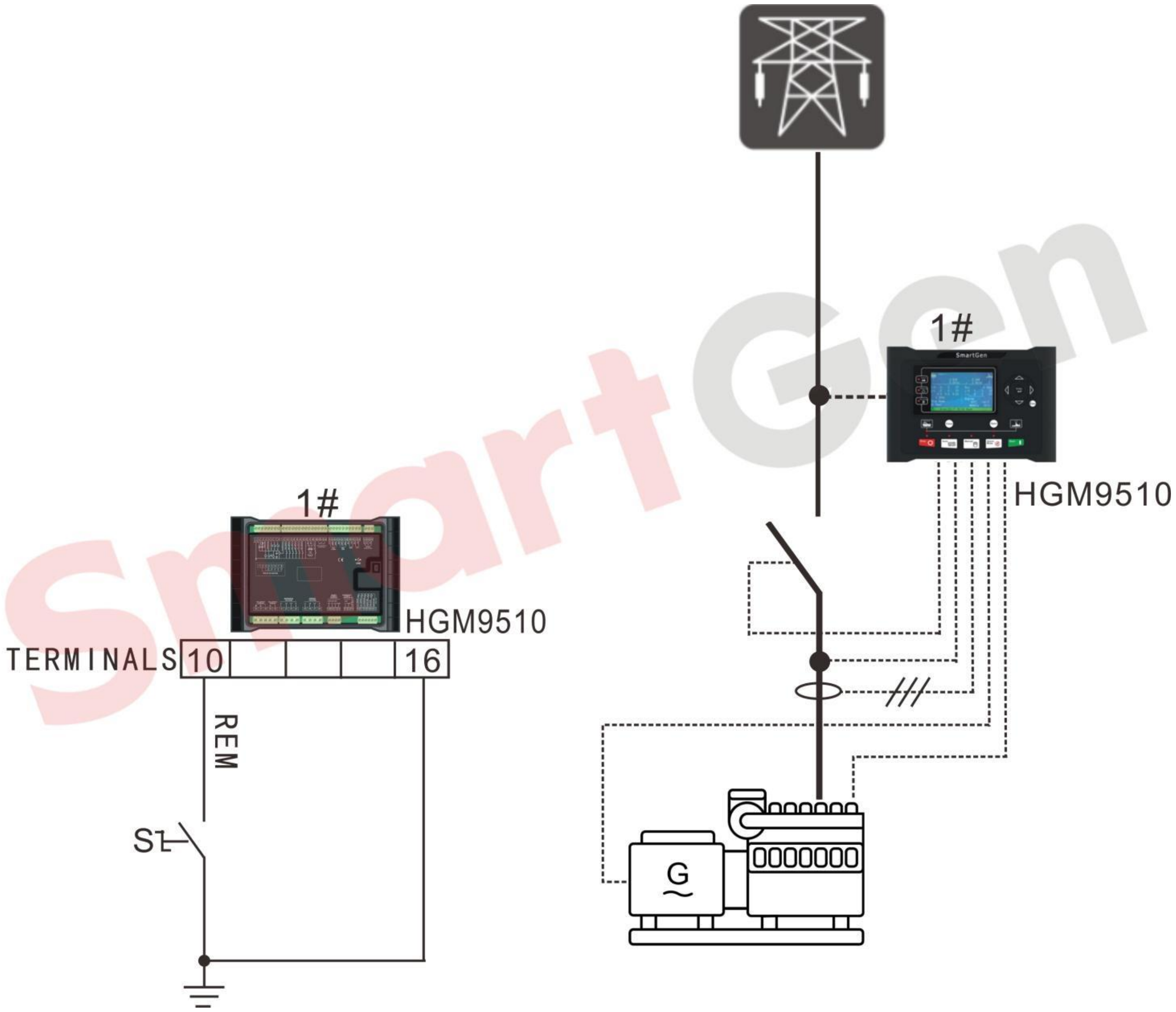


Fig. 11 Application diagram of single mains parallel with single Gen (Gen control)

Table 12 Parameter settings

Setting item	Setting parameters	Settings	Remark
Mains settings	Mains power supply system	3 Phase 4 Wire	
	Mains voltage	230V	
	Mains frequency	50Hz	
	Mains Split Setting	Enable: Frequency Change Rate, Vector Shift Mains undervoltage, mains overvoltage	

Setting item	Setting parameters	Settings	Remark
		Mains under-frequency, mains over-frequency	
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>	
	Rated speed	1500r/min	
	Crank disconnect condition	Gen frequency + rotating speed	
Generator Setting	AC power system	3 Phase 4 Wire	
	Gen rated voltage (rated voltage)	230V	
	Gen rated frequency (rated frequency)	50Hz	
	current transformer ratio	1500/5	Current transformer ratio＞ Full load rated current
	Full load rated current	1224A	Full load rated current =rated power ×1.8
	Full load rated active power (rated active power)	680kW	
	Full load rated reactive power (rated reactive power)	510kvar	Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)	
	Digital input port 4	Gen Close input	
	Digital input port 5	Mains parallel mode	
Output port settings	Digital output port 5	Gen Open output	
	Digital output port 6	Gen Close output	
Sync settings	The number of multi-set communication	1	
Synchronized calibration	Multi-set communication (MSC) ID	1	

Setting item	Setting parameters	Settings	Remark
	Module run priority	1	
	load mode	Gen control mode	
	Active power output	100% (680kW)	Active power output can be set according to site requirements.
	reactive power output	100% (510kvar)	Reactive power output can be set according to site requirements.
	GOV/AVR	GOV: (SW1: 5; SW2: 2) AVR: (SW1: 0; SW2: 2)	Refer to <HGM9500 controller GOV/AVR parameter setting>

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, the genset starts with load, and the genset works in the constant power output mode (the set active/reactive power value is the maximum output active/reactive power of the genset.).

1.4.2 Mains control mode (mains peak)

This solution is suitable for a genset parallel with mains, and the mains is loaded with constant power, while the extra load is borne by the genset. Can choose HGM9520 or HGM9520N controller. This solution is often used in situations where the mains capacity is insufficient.

Example 13: An ECU unit with a rated power of 650kW, and the AVR is MX321. The single unit is parallel with mains. Use HGM9520 controller.

A current transformer is needed on the mains and 3 current transformers is needed on Gens.

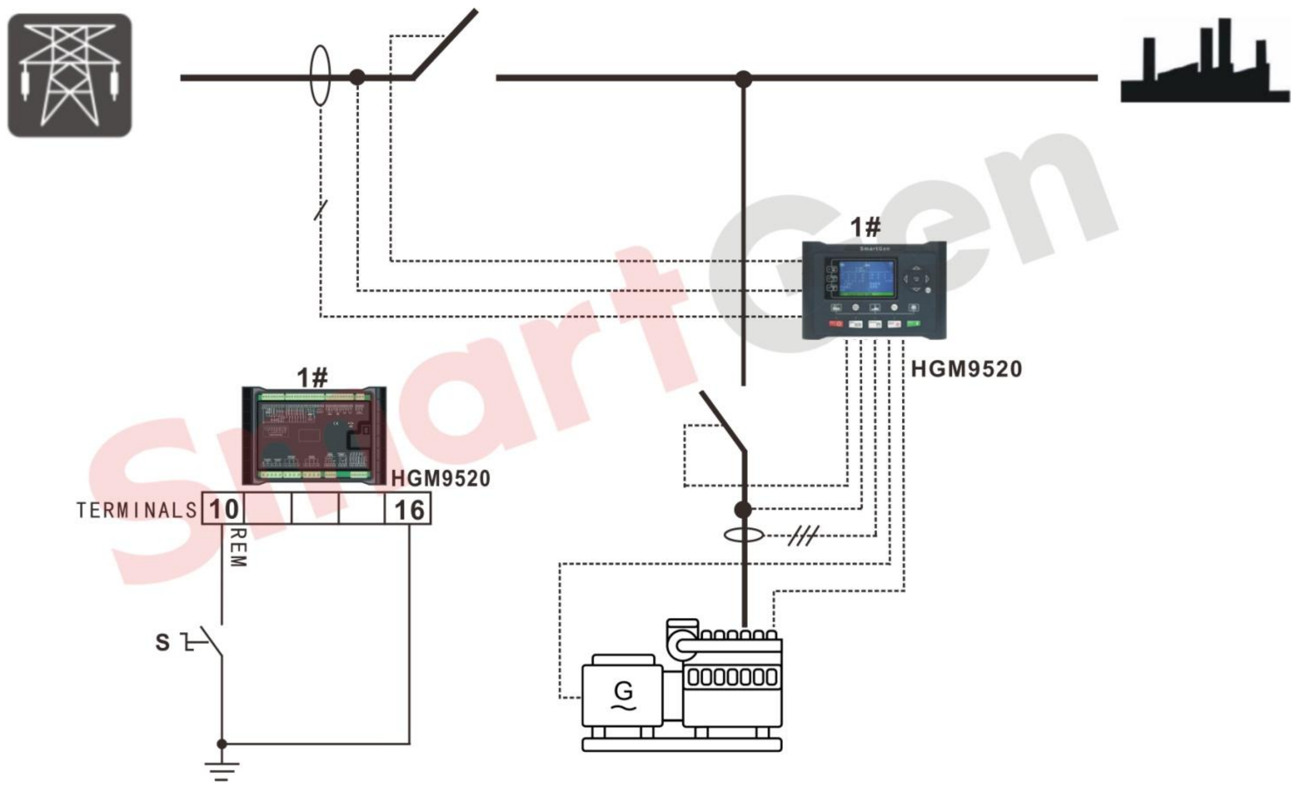


Fig. 12 Application diagram of single mains parallel with single Gen---Mains control mode (mains peak)

Table 13 Parameter settings

Setting item	Setting parameters	Settings	Remark
Mains settings	Mains power supply system	3 Phase 4 Wire	
	Mains voltage	230V	
	Mains frequency	50Hz	
	Mains current transformer	1200/5	
	full load active power	200kW	
	full load reactive power	150kvar	
	Mains Split Setting	Frequency Change Rate, Vector Shift Mains undervoltage, mains overvoltage Mains under-frequency, mains over-frequency	Fully enabled or partially enabled according to specific requirements.
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>	
	Rated speed	1500r/min	
	Crank disconnect condition	Gen frequency + rotating speed	
Generator Setting	AC power system	3 Phase 4 Wire	
	(rated voltage)	230V	
	Gen rated frequency (rated frequency)	50Hz	
	current transformer ratio	1200/5	
	Full load rated current (rated current)	1170A	Full load rated current =rated power × 1.8

Setting item	Setting parameters	Settings	Remark
	Full load rated active power (rated active power)	650kW	
	Full load rated reactive power (rated reactive power)	485kvar	Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)	
	Digital input port 4	Gen Close input	
	Digital input port 8	Mains Close input	
Output port settings	Digital output port 5	Gen Open output	
	Digital output port 6	Gen Close output	
	Digital output port 3	Mains Close output	
	Digital output port 4	Mains Open output	
Sync settings	The number of multi-set communication	1	
Synchronized calibration	Multi-set communication (MSC) ID	1	
	Module run priority	1	
	load mode	Mains control mode	
	Active power output (mains)	100% (200kW)	Mains active power output can be set according to site requirements.
	reactive power output (mains)	100% (150kvar)	Mains reactive power output can be set according to site requirements.
	GOV/AVR	GOV: (SW1: 5; SW2: 2) AVR: (SW1: 0; SW2: 2)	Refer to <HGM9500 controller GOV/AVR parameter setting>

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, the mains take load first. If the current load power is greater than the mains output active power of 200kW, the unit will be turned on and parallel with mains, and the generator will bear the excess load power, if the load power is less than the mains output active power of 200KW, the genset will be unloaded and stopped.

1.4.3 Mains control mode (Gen peak)

This solution is suitable for a genset parallel with mains, and the mains is loaded with constant power, while the extra load is borne by the genset. Can choose HGM9520 or HGM9520N controller. This solution is often used in situations where the mains capacity is limited.

Example 13: An ECU unit with a rated power of 650kW, and the AVR is MX321. The single unit is parallel with mains. Use HGM9520 controller. A current transformer is needed on the mains and 3 current transformers is needed on Gens.

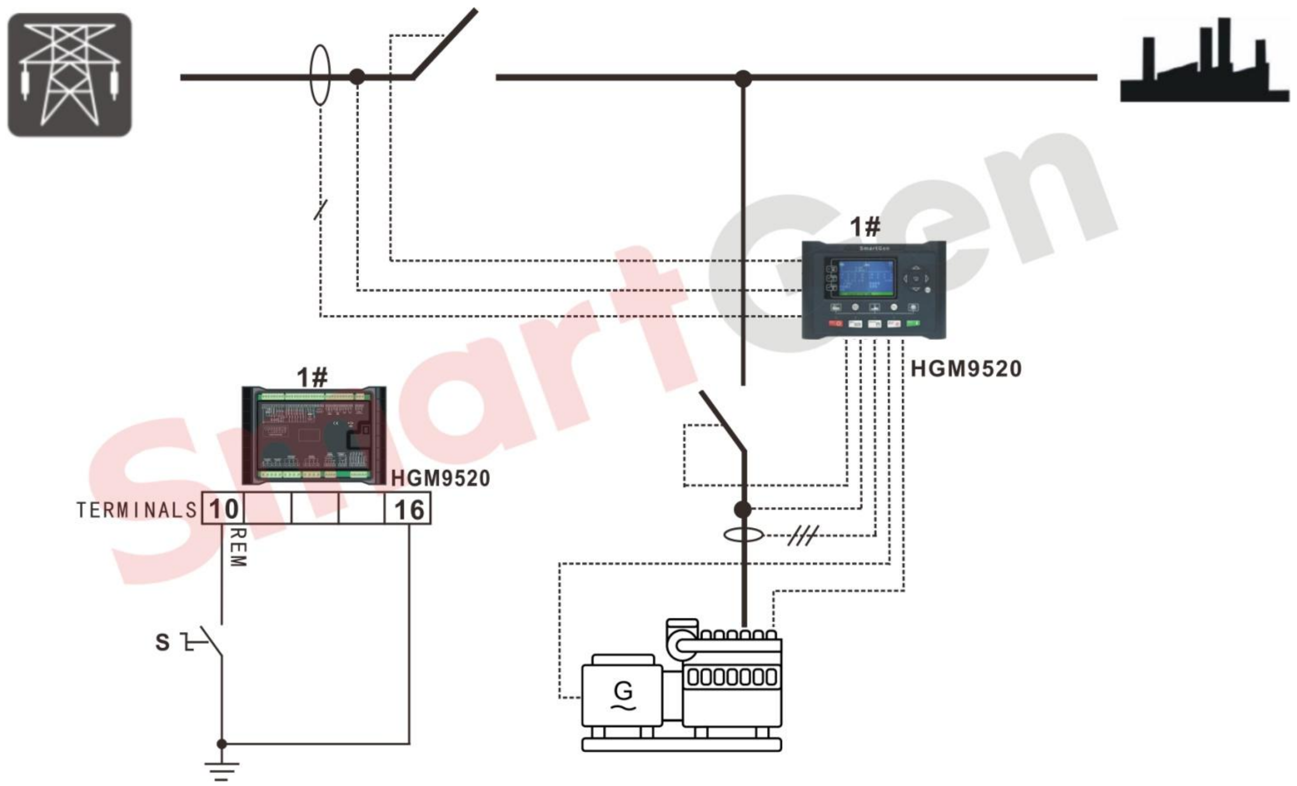


Fig. 13 Application diagram of single mains parallel with single Gen---Mains control mode (Gen peak)

Table 14 Parameter settings

Setting item	Setting parameters	Settings	Remark
Mains settings	Mains power supply system	3 Phase 4 Wire	
	Mains voltage	230V	
	Mains frequency	50Hz	
	Mains current transformer	600/5	
	full load active power	300kW	

Setting item	Setting parameters	Settings	Remark
	full load reactive power	222kvar	
	Mains Split Setting	Frequency Change Rate, Vector Shift Mains undervoltage, mains overvoltage Mains under-frequency, mains over-frequency	Fully enabled or partially enabled according to specific requirements.
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>	
	Rated speed	1500r/min	
	Crank disconnect condition	Gen frequency + rotating speed	
Generator Setting	AC power system	3 Phase 4 Wire	
	Gen rated voltage (rated voltage)	230V	
	Gen rated frequency (rated frequency)	50Hz	
	current transformer ratio	1200/5	
	Full load rated current (rated current)	1170A	Full load rated current =rated power × 1.8
	Full load rated active power (rated active power)	650kW	
	Full load rated reactive power (rated reactive power)	485kvar	Set according to the power factor of 0.8
Input port setting	Digital input port 1	Remote Start (on demand)	
	Digital input port 4	Gen Close input	
	Digital input port 8	Mains Close input	

Setting item	Setting parameters	Settings	Remark
Output port settings	Digital output port 5	Gen Open output	
	Digital output port 6	Gen Close output	
	Digital output port 3	Mains Close output	
	Digital output port 4	Mains Open output	
Sync settings	The number of multi-set communication	1	
Synchronized calibration	Multi-set communication (MSC) ID	1	
	Module run priority	1	
	load mode	Mains control mode	
	Active power output (mains)	10% (30kW)	Mains active power output can be set according to site requirements.
	reactive power output (mains)	10% (22kvar)	Mains reactive power output can be set according to site requirements.
	GOV/AVR	GOV: (SW1: 5; SW2: 2) AVR: (SW1: 0; SW2: 2)	Refer to <HGM9500 controller GOV/AVR parameter setting>

If all above parameter settings are completed and the controller is in auto mode, when the remote start input is active, the mains take load first. If the current load power is greater than the mains output active power of 30kW, the unit will be turned on and parallel with mains, and the generator will bear the excess load power, if the load power is less than the mains output active power of 30KW, the genset will be unloaded and stopped.

1.4.4 Busbar mode of single mains parallel with multi Gens

This solution is suitable for one way mains parallel with multiple gensets. HGM9510 or HGM9510N controller + HGM9560 controller is advised.

Example 14: Four Gas ECU units with rated power of 500kW and the AVR is SX440. Totally four units are required to parallel first, and then Gen Bus parallel with Mains to take load.

Note: According to the requirements, 4 pcs HGM9510 controllers, 1pc HGM9560 controller, 4pcs 1000A generator switches, 1pc 1000A mains switch, and 1pc 3200A load output switch are required. The busbar current of HGM9560 needs to be detected, so a current transformer on the busbar side and three current transformers on the mains side are required.

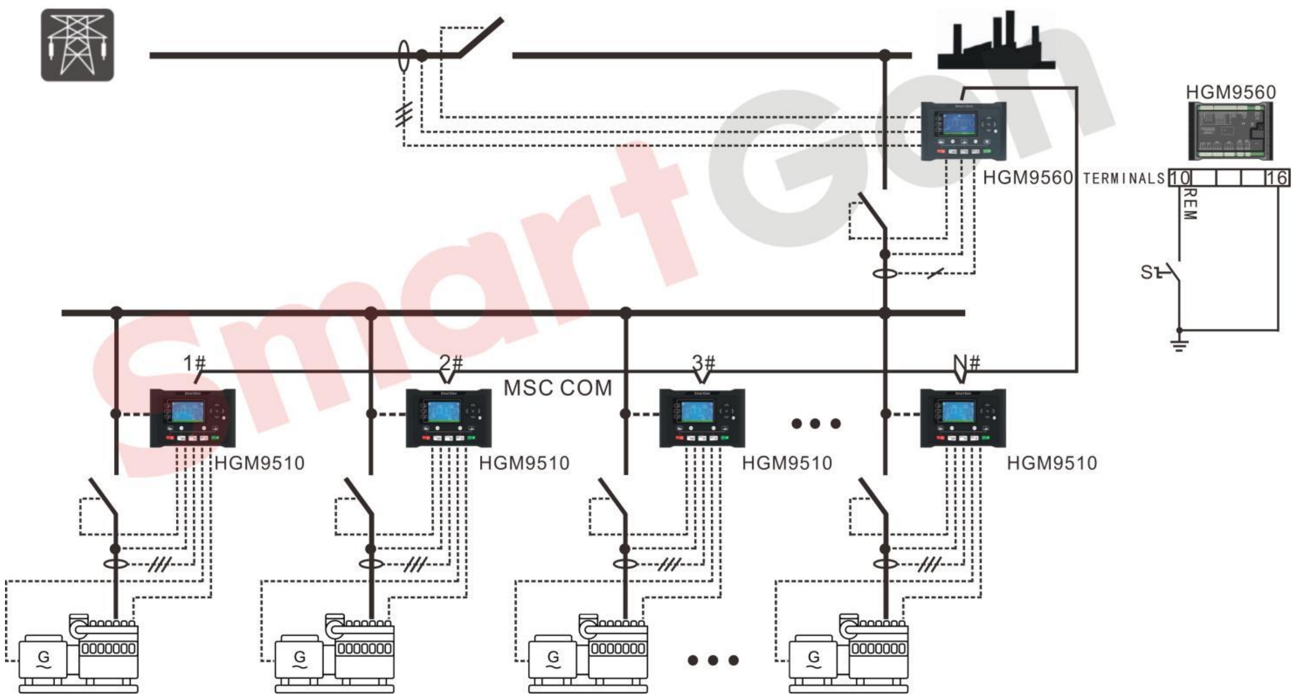


Fig.14 Application diagram of single mains parallel with multi Gens

Table 15 Parameter settings

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
HGM9510 Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>				
	Rated speed	1500r/min				
	Crank disconnect condition	Gen frequency + rotating speed				
HGM9510 Generator Setting	AC power system	3 Phase 4 Wire				
	Gen rated voltage (rated voltage)	230V				
	Gen rated frequency (rated frequency)	50Hz				
	current transformer ratio	1000/5				
	Full load rated current (rated current)	900A				Full load rated current =rated power ×1.8
	Full load rated active power	500kW				

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
	(rated active power)					
	Full load rated reactive power (rated reactive power)	380kvar				Set according to the power factor of 0.8
HGM9510 Input port setting	Digital input port 4	Gen Close input				
HGM9510 Output port settings	Digital output port 5	Gen Open output				
	Digital output port 6	Gen Close output				
HGM9510 Sync settings	The number of multi-set communication	4				
	Start options	All power on (start on demand)				1. Start all gensets when the HGM9560 is in the busbar control mode. 2. Start on demand When the HGM9560 is in the mains control mode.
	Scheduled on Load Percentage (Maximum load percentage at start)	80%				1. Scheduled on power = full-load active power of N units which currently connected in parallel × scheduled on load percentage 2. Scheduled on Load Percentage = Scheduled on power /full-load active power of N units which currently connected in parallel ⚠ **Note: "N" indicates the number of paralleled units. In this example, N=1 when the second unit is scheduled on, N=2 when the third unit is**

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						scheduled on, and N=3 when the fourth unit is scheduled on.
	Scheduled Stop Load Percentage (Maximum load percentage at stop)	40%				1. Scheduled stop power = full-load active power of N units which currently connected in parallel × $\frac{(N-1)}{N}$ ×scheduled stop load percentage 2. Scheduled stop Load Percentage = Scheduled stop power /full-load active power of N units which currently connected in parallel× $\frac{N}{(N-1)}$ **Note: "1" in the formula represents the unit with the lowest priority to be stopped among the parallel units; "N" represents the number of parallel units.** **In this example, N=4 when the fourth unit is scheduled stop, N=3 when the third unit is scheduled stop, and N=2 when the second unit is scheduled stop.** **Note: Scheduled stop power refers to the load power.** **Note: When there are several parallel units, it is recommended to reduce the scheduled stop load**

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
						percentage to avoid frequent start and stop of units.
HGM9510 Synchronized calibration	Multi-set communication (MSC) ID	1	2	3	4	
	Module run priority	1	2	3	4	
	Active power output	100% (500kW)				Active power output can be set according to site requirements.
	reactive power output	100% (380kvar)				Reactive power output can be set according to site requirements
	GOV/AVR	GOV: (SW1: 5; SW2: 2) AVR: (SW1: 0; SW2: 2)				Refer to <HGM9500 controller GOV/AVR parameter setting>
HGM9560 Mains settings	Mains power supply system	3 Phase 4 Wire				
	Mains voltage	230V				
	Mains frequency	50Hz				
	Mains current transformer	2000/5				
	full load active power	1000kW				
	full load reactive power	760kvar				
	Mains Split Setting	Enable: Frequency Change Rate, Vector Shift Mains undervoltage, mains overvoltage Mains under-frequency, mains over-frequency				
HGM9560 Busbar settings	AC power mode	3 Phase 4 Wire				
	busbar rated voltage	230V				
	Busbar rated frequency	50Hz				
	Current Transformer	4000/5				
	Full load rated active	2000kW				

Setting item	Setting parameters	Settings				Remark
		Unit 1	Unit 2	Unit 3	Unit 4	
	power					
	Full load rated reactive power	1526kvar				
HGM9560 Input port setting	Digital input port 1	Remote power on (on demand)				
	Digital input port 4	Busbar close status input				
	Digital input port 8	Mains Close input				
HGM9560 Output port settings	Digital output port 5	Mains Close output				
	Digital output port 6	Busbar close output				
	Digital output port 7	Mains Open output				
	Digital output port 8	Busbar open output				
HGM9560 Sync settings	The number of multi-set communication	4				Refers to the number of communication module.
	Minimum number of starting units	1				
HGM9560 Synchronized calibration	Multi-machine communication ID	1				
	Module run priority	1				
	load mode	Busbar Control Mode				1. It is mains peak lopping mode if the mains control mode is selected. that is, the mains take load mainly, and when the mains is out of range or the mains is abnormal, the busbar take load. 2. If busbar control mode is selected, it is constant power mode. Busbar constant power output.
	Active power output	100% (2000kW)				In mains mode, active power output is 100% (1000kW)
	reactive power output	100% (1526kvar)				In mains mode, reactive power output is 100% (760kvar)

If all above parameter settings are completed:

——If the mains is closed and loaded, when the HGM9560 is selected as the busbar control mode,

while the HGM9510 and HGM9560 controllers are in auto mode, and when the HGM9560 remote start input is valid, all four units are turned on and connected in parallel. After the busbar is closed, it is parallel with mains and loaded. The maximum load power of the busbar is 2000KW.

——When the HGM9510 and HGM9560 controllers are in auto mode, and the HGM9560 selects as mains control mode, then the mains switch is closed first with load. If the current load power is less than or equal to 1000KW, the mains takes load. If 1000KW ＜ current load power ≤ 1400kW, when HGM9560 remote start (on demand) is active, unit 1 is closed and connected in parallel with mains, and the generator busbar is loaded with load power below 400kW; if 1000KW ＜current load power When ≤1800kW, unit 2 is closed and connected in parallel with mains, and the generator busbar is loaded with load power below 800kW; if 1000KW ＜ current load power ≤2200kW, unit 3 is closed and connected in parallel with mains, and the generator busbar is loaded with load power below 1200kW; if 1000KW ＜ current load power ≤ 3000kW, unit 4 is closed and connected in parallel with mains, and the generator busbar is loaded with load power below 2000kW.

——If the current load power is less than 1600kW, unit 4 is unloaded and stopped, and the generator busbar is loaded with load power below 600kW; if the current load power is less than 1400kW, unit 3 is unloaded and stopped, and the generator busbar is loaded with load power below 400kW; if the current load power When it is less than 1200kW, unit 2 is unloaded and stopped, the power generation busbar is loaded with load power below 200kW. If the current total load power is lower than the mains active output power of 1000kW, after unit 1 is unloaded, the busbar is opened, then the unit 1 is turned off and the mains is loaded.

——When HGM9560 and HGM9510 both in AUTO mode, and “Load Mode” select as “Bus”, if Mains fail, Mains breaker will open and Generator start to take the load. The Bus largest loading power is 2000KW.

——When controller in AUTO mode, and “Load Mode” select as “Mains”, If Mains fail, Gen 1 start and close breaker, Bus breaker close, and the Gen Busbar take the load; If the current load is greater than scheduled power 800kW,Gen 2 starts and synchronizes with busbar to equally share the load; If the current load is greater than scheduled power 800kW,Gen 3 starts and synchronizes with busbar to equally share the load; If the current load is greater than scheduled power

1200kW,Gen 4 starts and synchronizes with busbar to equally share the load; If the current load is greater than 2000kW, HGM9560 sends over power shutdown alarm, and four gensets shutdown. If the current load is lower than 600kW, Gen 4 unloads and shutdown, and Gen busbar shares the load. If the current load is lower than 400kW, Gen 3 unloads and shutdown, and Gen busbar shares the load. If the current load is lower than 200kW, Gen 2 unloads and shutdown, and Gen busbar shares the load.

——When controller in AUTO mode, and “Load Mode” select as “Mains”, When Mains is normal, Mains and generators will anti-synchronize, and after synchronizing is completed, controller will start/stop gensets according to the scheduled power.

Note: During Mains fail and before GCB close, there is no power for load; During Manis normal and Mains supply completed, there is continuous power for load.

1.4.5 Multi Mains and Multi Gens Synchronizing Mode

This solution suits for muti Mains and multi generators synchronization, users can select HGM9510/HGM9510N + HGM9560 controllers. Applications include: factories, hospitals, etc.

Example 15:Three 700kW gas EFI gensets with SX440 AVR, there are three channels of Mains and three channels of loads. Normally, Mains is loaded when Mains normal and generator is loaded when the Mains has failure.

Note: As requirement, customers need to prepare 3xHGM9510 and 3xHGM9560 controllers, 3x1500A breakers for generators， 3x1500A breakers for Mains, and 3x3000A breakers for Busbar synchronized with Mains. Since the busbar current needs to be detected on the HGM9560, a current transformer is needed to add on the busbar.

When multiple channels of Mains in the system, multiple HGM9560 controllers control the start/stop of HGM9510 controllers dispatching gensets through MSC communication to supply power for multiple channels of load.

HGM9560 and HGM9510 work in AUTO mode.

——When “Starting Option” choose “Start Sets as Load Require”.

1) When there's one channel Mains fails, the HGM9560 of this channel detects voltage fault and initiates start signals to multiple HGM9510 controllers via MSC communication, and then genset with high-priority is powered on and loaded.
2) When multiple channels of Mains fail, and the busbar power reaches the scheduled start-up power, HGM9510 will start the remaining gensets in synchronization to supply power to multiple loads according to the order of priority from high to low.
3) When one channel of Mains back to normal, after the HGM9560 of this channel detects normal voltage from this Mains, it will control Mains anti-synchronized with generators busbar, and then close MCB and open the busbar breaker. HGM9560 sends a stop signal to HGM9510 through MSC communication, and the genset with the lowest priority stops.
4) When multiple channels of Mains back to normal, after the HGM9560 of each channel detects normal voltage from this Mains, HGM9560 controllers will control each Mains synchronized with busbar one by one, and then close MCBs to loaded and open the busbar breakers. Each HGM9560 sends a shutdown signal to HGM9510 through MSC communication, and multiple gensets are shut down in order of priority from low to high.

——When HGM9510 "Starting Option" choose "Start All Sets Initially".

1) When one Mains or multiple Mains fail, after the HGM9560 controller detect Mains voltage fault, it will initiate start signals to multiple HGM9510 controllers via MSC communication to start all gensets running in synchronization and loaded.
2) When one channel of Mains back to normal, after the HGM9560 of this channel detects normal voltage from this Mains, it will control Mains anti-synchronized with generators busbar, and then close MCB and open the busbar breaker. Multiple gensets continue o work normally.
3) When every channel of Mains back to normal, after the HGM9560 of each channel detects normal voltage from each Mains, it will control related Mains anti-synchronized with generators busbar, and then close MCB and open the busbar breaker. Each HGM9560 sends a shutdown signal to HGM9510 through MSC communication, and multiple gensets are shut down in order of priority from low to high.

HGM9560 priority can be divided into status priority and module priority. If status priorities are different, then the HGM9560 priority is up to the status priorities; If status priorities are same, then the HGM9560 priority is up to the module priority;

The module priority can be set by users, while the status priority cannot be set.

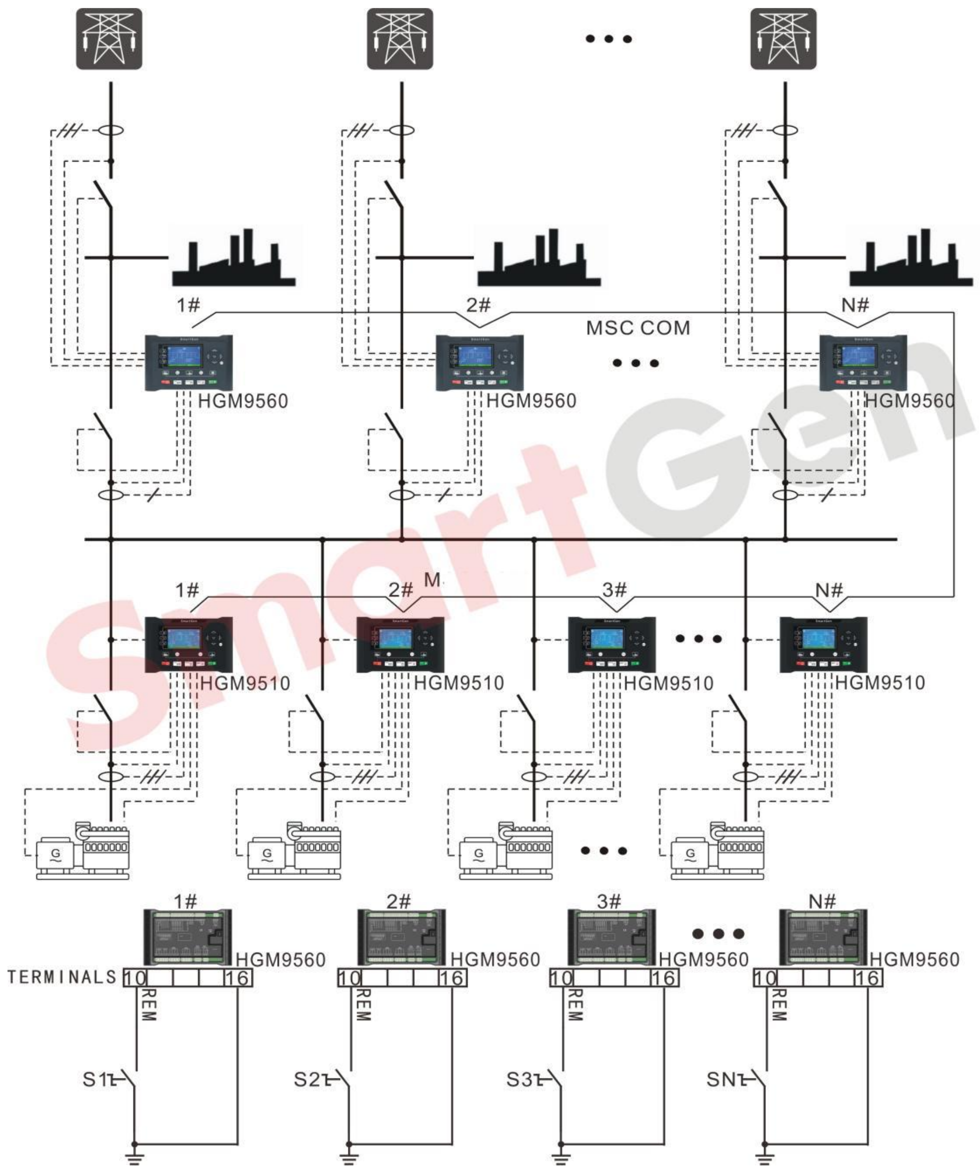


Fig.15 Multiple Mains and Multiple Generators Synchronizing Application

Table 16 Multiple Mains and Multiple Generators Synchronizing Application Parameters

Items	Parameters	Setting Values			Remark
		Gen1	Gen2	Gen3	
HGM9510 Engine Settings	Engine Type	Refer to<Parameter Setting of EFI Unit>			
	Rated speed	1500r/min			
	Crank disconnect conditions	Gen frequency + Speed			
HGM9510	AC system	3 Phase 4 Wire			

<table>
<tr><th rowspan="2">Items</th><th rowspan="2">Parameters</th><th colspan="3">Setting Values</th><th rowspan="2">Remark</th></tr>
<tr><th>Gen1</th><th>Gen2</th><th>Gen3</th></tr>
<tr><td rowspan="6">Generator Settings</td><td>Gen rated voltage (rated voltage)</td><td colspan="3">230V</td><td></td></tr>
<tr><td>Gen rated frequency (rated frequency)</td><td colspan="3">50Hz</td><td></td></tr>
<tr><td>CT primary</td><td colspan="3">150/5</td><td>CT select ＞ full load rating current</td></tr>
<tr><td>Full load rating current (rated current)</td><td colspan="3">1260A</td><td>Full load rating current=rated power × 1.8</td></tr>
<tr><td>Full kW rating (rated active power)</td><td colspan="3">700kW</td><td></td></tr>
<tr><td>Full Kvar rating (rated reactive power)</td><td colspan="3">520kvar</td><td>based on power factor 0.8</td></tr>
<tr><td>HGM9510 Digital Inputs Settings</td><td>Digital input port 4</td><td colspan="3">Generator closed auxiliary</td><td></td></tr>
<tr><td rowspan="2">HGM9510 Relay Outputs Settings</td><td>Relay output 5</td><td colspan="3">Open gen output</td><td></td></tr>
<tr><td>Relay output 6</td><td colspan="3">Close gen output</td><td></td></tr>
<tr><td rowspan="3">HGM9510 Sync Settings</td><td>MSC number</td><td colspan="3">3</td><td></td></tr>
<tr><td>Starting options</td><td colspan="3">Start sets as require (start all sets initially)</td><td>1. Start sets as require:Start gensets based on each channel of load when Mains fail; When Mains return, gensets will stop based on load.
2. Start all sets initially: All gensets start when Mains fail, and when all Mains return gensets will stop.</td></tr>
<tr><td>Calling for more sets (maximum load percentage when to start genset)</td><td colspan="3">80%</td><td>Power(when calling for more sets)=full loading power of N synchronizing gensets ×</td></tr>
</table>

Items	Parameters	Setting Values			Remark
		Gen1	Gen2	Gen3	
					calling for more sets percentage 2. Calling for more sets percentage= power (when calling for more sets)/ full loading power of N synchronizing gensets **Note: "N" means the number of synchronized gensets.** In this example, if calling for No.2 genset to start, N=1. if calling for No.3 genset to start, N=2. if calling for No.4 genset to start, N=3.
	Calling for less sets (minimum load percentage when to stop genset)	40%			1. Power(when calling for less sets)= full loading power of N synchronizing gensets × $\frac{(N-1)}{N}$x calling for less sets percentage 2. Calling for less sets percentage= Power(when calling for less sets)/ full loading power of N synchronizing gensets × $\frac{(N-1)}{N}$ **Note: "1"in the formula means the genset with the lowest priority in synchronizing gensets to be stopped; "N" means the number of synchronized gensets.** **In this example, if calling**

Items	Parameters	Setting Values			Remark
		Gen1	Gen2	Gen3	
					for No.3 genset to stop, N=3. if calling for No.2 genset to stop, N=2. if calling for No.1 genset to start, N=1. **⚠ Note: power when calling less gensets is means loading power.** **⚠Note: when too many gensets running in synchronization, we suggest to reduce the calling for less units percentage to avoid gensets start/stop frequently.**
HGM9510 Sync. Calibration	MSC ID	1	2	3	
	Module priority	1	2	3	
	Active power output	100%(700kW)			Users can set active power output according to the site requirements.
	Reactive power output	100%(520kvar)			
	GOV/AVR	GOV:(SW1:5; SW2:2) AVR:(SW1:0; SW2:2)			Refer to <HGM9500 controller GOV/AVR parameter setting>
HGM9560 Mains Settings	Mains AC system	3P4W			
	Mains voltage	230V			
	Mains frequency	50Hz			
	Mains CT primary	1500/5			
	Full load kW power	700kW			
	Full load kvar power	520kvar			
	Mains decoupling setting	Enable: R.O.C.O.F, Vector shift, Mains under voltage, Mains over voltage, Mains under			

Items	Parameters	Setting Values			Remark
		Gen1	Gen2	Gen3	
		frequency, Mains over frequency			
Bus Settings	AC system	3P4W			
	Bus voltage	230V			
	Bus frequency	50Hz			
	Bus CT primary	1500/5			
	Bus full load kW power	700kW			
	Bus full load kvar power	520kvar			
HGM9560 Input Settings	Digital input port 4	Bus closed auxiliary			
	Digital input port 8	Mains closed auxiliary			
HGM9560 Output settings	Relay output 5	Close mains output			
	Relay output 6	Close Bus output			
	Relay output 7	Open Mains output			
	Relay output 8	Open Bus output			
HGM9560 Sync Settings	MSC No.	3			Refers to the number of gensets in communication.
	Minimum number of sets	1			
HGM9560 Sync. Calibration	MSC ID	1	2	3	
	Module priority	1	2	3	

If above settings completed, HGM9560 and HGM9510 controllers in AUTO mode, three channels of Mains will supply three channels of load when Mains normal.

——When HGM9510 “Starting Option” choose “Start Sets as Load Require”.

1) If either Mains fails, the corresponding MCB will open, Genset 1 will start and the corresponding Bus breaker will close. If current load power＜560kw, Gen 1 will take the load. If any one of the current load power ＞ 560kW or any two channels of Mains fail and 560kW ＜ current load power ≤ 1120kW, Gen 2 will start and synchronize with Gen1 to share the load with Gen2. If any two channels of current load power ＞ 1120kW or three channels of Mains fail and 1120kW<current load power≤2100kW,Gen 3 will start and synchronize with Bus to share the load with Gen2 and Gen1.
2) When three channels of load are all powered by Gens, if any one channel of Mains return, the corresponding Mains will anti-synchronize with Gens and take the load from the Gen, and the

corresponding Bus breaker will open. If the current load power ＞560kW, three Gens will share the load. If 280kw＜current load power≤560kW, Gen3 will open breaker and stop. If either channel of other two Mains returns, the corresponding Mains will anti-synchronize with Gens and take the load from the Gen, and the corresponding Bus breaker will open. If current load power≤280kW, Gen2 will open breaker and stop. If all three channels of Mains return, the last channel of Mains will anti-synchronize with Gens and take the load from the Gen, and the corresponding Bus breaker will open, and Gen1 will open breaker and stop.

——When HGM9510 “Starting Option” choose “Start All Sets Initially”.

1) If Mains fail, all gensets will run in synchronization and take the load.
2) If one or two channels of Mains return, the corresponding Mains will anti-synchronize with the Gen Bus, MCB will close and related Bus breaker will open. Three gensets keep running normally.
3) If all three channels of Mains return, the corresponding Mains will anti-synchronize with the Gen Bus, MCB will close and related Bus breaker will open. And then three gensets will stop in order of priority from low to high.

Note: After Mains fail but before GCB closed, there is no power supply for load; and from Mains return and Mains loaded, there is uninterrupted power for the load.

1.4.6 Load Mode: Takeover Application

This application is suitable for one generator synchronized running with Mains, load can be transferred from Mains and Gen. Customers can choose HGM9520 or HGM9520N controller. Application scenarios include: harbors, inshore/offshore, entry/exit the port, and planned power outages.

Example 16: 1x750kW EFI generator, AVR model is SX440, when the controller receives the switch signal between the Mains and the generator, the generator and the mains can automatically switch to be loaded.

Note: Controller must connect to Mains CT if customers choose the Load Mode of HGM9520 to realize the generator and Mains automatically switch to be loaded based on the requirement.

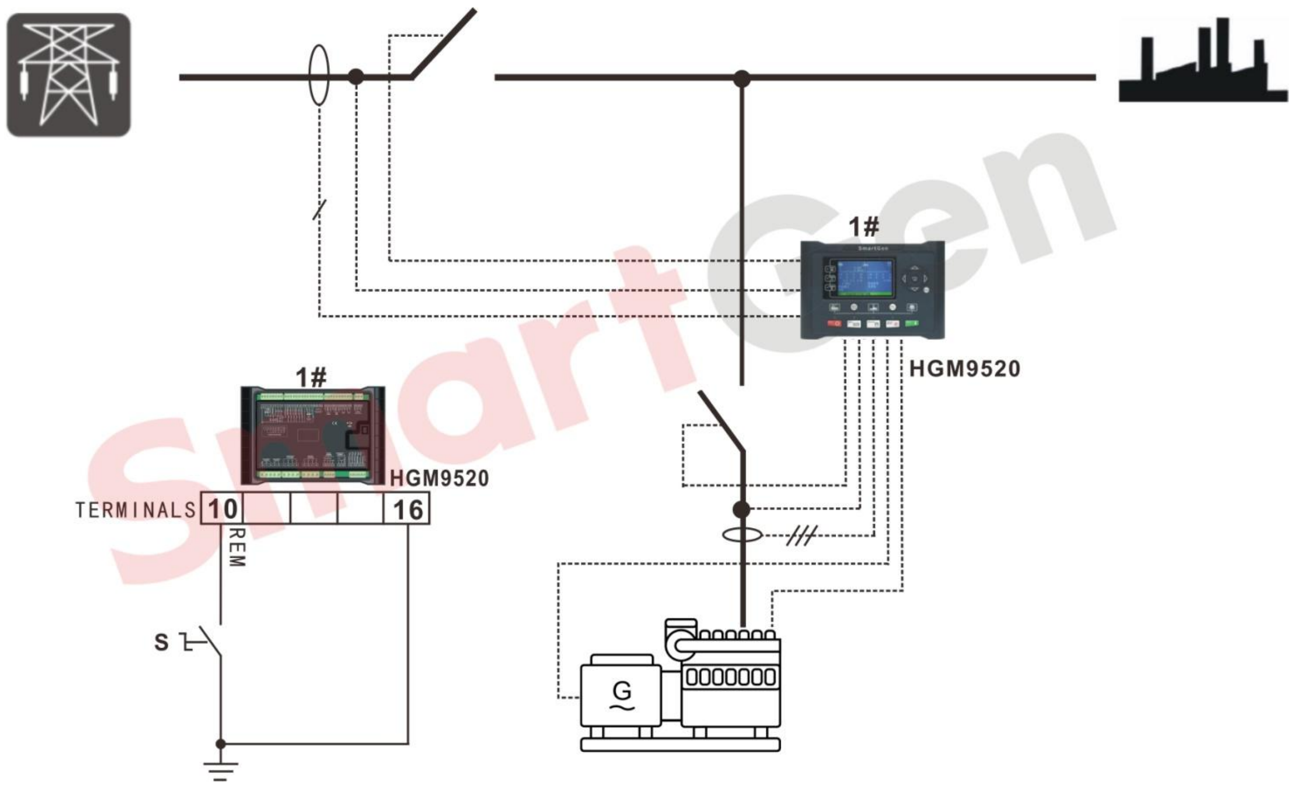


Fig.16 Takeover Load Mode Application Diagram

Table 17 Takeover Load Mode Parameters Settings

Items	Parameters	Setting Values	Remark
Mains Settings	AC system	3P4W	
	Voltage	230V	
	Frequency	50Hz	
	CT primary	1200/5	
	Full load rating	600kW	
	Load kvar rating	443kvar	
	Mains decoupling	Enable: R.O.C.O.F, Vector Shift, Mains Under Voltage, Mains Over Voltage, Mains Under Frequency, Mains Over Frequency	
Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>	
	Rated speed	1500r/min	
	Crank disconnect	Frequency + Speed	

Items	Parameters	Setting Values	Remark
	conditions		
Generator Settings	AC system	3P4W	
	Rated voltage	230V	
	Rated frequency	50Hz	
	CT primary	1500/5	CT selection＞full loading rated current
	Full load rating (rated current)	1350A	Full load rating=rated power×1.8
	Full kW rating (rated kW power)	750kW	
	Full kvar rating (rated kvar power)	555kvar	Setting based on PF 0.8
Digital Inputs Settings	Digital input 1	Remote start (island mode)	
	Digital input 4	Generator closed auxiliary	
	Digital input 8	Mains closed auxiliary	
Relay Outputs Settings	Relay output 5	Open gen output	
	Relay output 6	Close gen output	
	Relay output 3	Close Mains output	
	Relay output 4	Open Mains output	
Sync. Settings	MSC number	1	
Sync. Calibration	Load mode	Load takeover mode	
	GOV/AVR	GOV:(SW1:5; SW2:2) AVR:(SW1:0; SW2:2)	Refer to <HGM9500 controller GOV/AVR parameter setting>

After above parameters set completely, and controller is in Auto mode:

——When generator needs to supply to the load, activate “Remote start (island mode)”, generator will start and synchronize with Mains, and all the load will transfer from Mains to generator, and then MCB will open. All the load are powered from generator.

——When Mains needs to supply to the load, deactivate “Remote start (island mode)”,Mains will anti-synchronize with generator, and all the load will transfer from generator to Mains, and then GCB will open and stop.

1.4.7 The application of “Load Control Mode”

This project is suitable for one generator (this generator is considered as Mains) synchronized with one generator equipped with HGM9520 control system to share the load in proportion.

Example 17: There are two EFI gensets, the rated power of genset 1 is 640kW; and genset 2 equipped with HGM9520 control system is 720kW. Both gensets AVR is SX440. A synchronizing controller is used to evenly share the load between two gensets.

Note: Choose the “Load Mode” of HGM9520 based on the requirement to realize use one synchronizing controller to share the load proportionally between two gensets. HGM9520 will control circuit close/open, and not control the genset start or stop. In this mode, Mains parameters are configured as generator parameters in ASM control system. One CT needs to be installed in the end of ASM generator and connect with HGM9520 current sampling terminals (terminal 53, terminal 54).

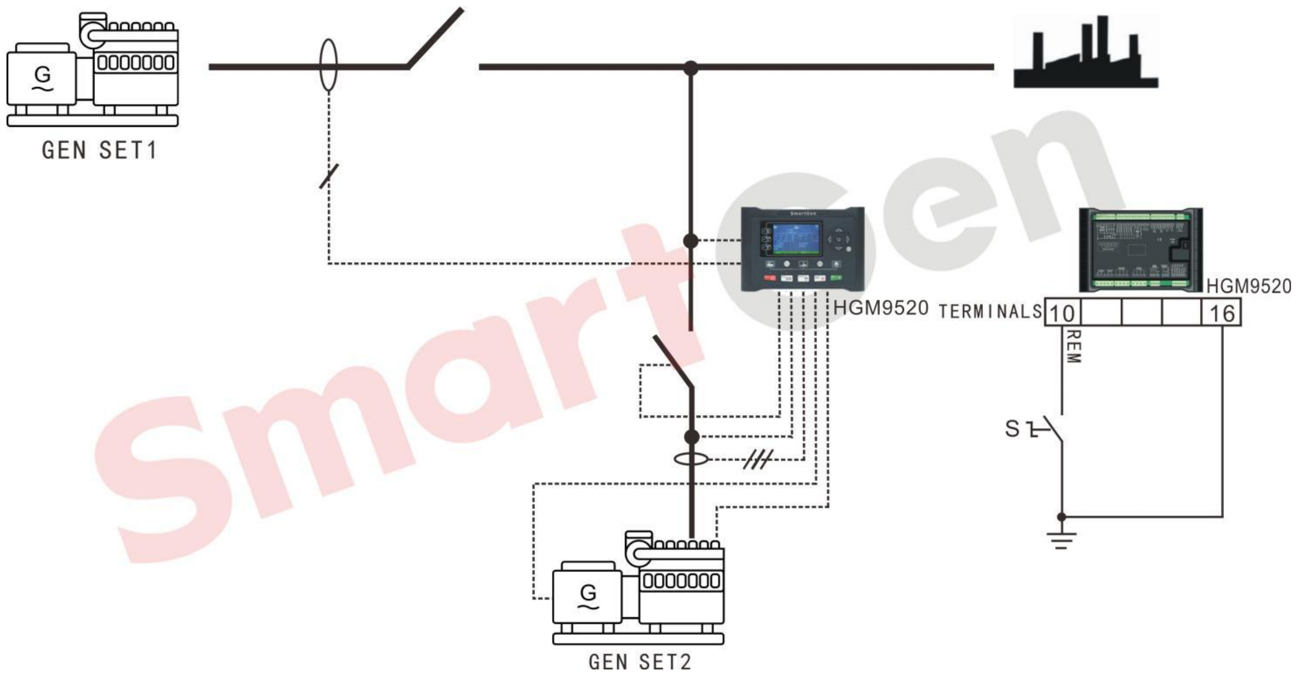


Fig. 17 Load Control Mode Application Diagram

Table 18 Parameters Settings of Load Control Mode Application

Items	Parameters	Settings	Remark
Mains Settings	AC system	3P4W	ASM control system parameters
	Voltage	230V	
	Frequency	50Hz	
	CT primary	1200/5	
	Full load rating	640kW	
	Load kvar rating	475kvar	

Items	Parameters	Settings	Remark
Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>	
	Rated speed	1500r/min	
	Crank disconnect conditions	Frequency + Speed	
Generator Settings	AC system	3P4W	
	Rated voltage	230V	
	Rated frequency	50Hz	
	CT primary	1500/5	CT selection＞full loading rated current
	Full load rating (rated current)	1296A	Full load rating=rated power × 1.8
	Full kW rating (rated kW power)	720kW	
	Full kvar rating (rated kvar power)	535kvar	Setting based on PF 0.8
Digital Inputs Settings	Digital input 1	Remote start(Start Sets as Load Require)	
	Digital input 4	Generator closed auxiliary	
Relay Outputs Settings	Relay output 5	Open gen output	
	Relay output 6	Close gen output	
Sync. Settings	MSC number	1	
Sync. Calibration	Load mode	Load Control Mode	
	Active power output	40%(Mains: 40%; Gen: 60%)	Mains is ASM genset parameters
	Reactive power output	40%(Mains: 40%; Gen: 60%)	Mains is ASM genset parameters
	GOV/AVR	GOV:(SW1:5; SW2:2) AVR:(SW1:0; SW2:2)	Refer to <HGM9500 controller GOV/AVR parameter setting>

After above settings completed:

——If the current loading power is 800kW, and Gen 1 is running with load, when HGM9520 is in AUTO mode and remote start is active, Gen 2 will start and synchronize with Gen 1. The current loading power will be distributed proportionally according to the active power output setting, with

Gen 1 carrying 320kW and Gen 2 carrying 480kW.

——If the current loading power 1300kW, Gen 1 synchronizes with Gen 2 loaded together. The current loading power will be distributed proportionally according to the active power output setting, with Gen 1 carrying 520kW and Gen 2 carrying 780kW.

——If the loading power is bellow 640kW, the remote start input signal will be disconnected, and the load will transfer from Gen 2 to Gen 1, and then Gen 2 will be stopped.

Caution: If the load is above the rated power of each generator, don not disconnect the remote start input signal to avoid generator overload shutdown.

1.4.8 AMF control mode application

This application is suitable for after one generator synchronize with Mains, the load will transfer from Mains and generator. In this case, HGM9520 or HGM9520N can be chose to applicate in plant, school, supermarket etc.

Example 18, one EFI 900kW generator with SX440 AVR, when Mains is faulty, generator will take the load; when Mains return, Mains will take the load and generator will stop automatically.

Note: Choose AMF control mode of HGM9520 based on the requirement to realize Mains or Gen to take the load. CT needs to be connected to the Mains side, and set the current transformer ratio, full load active power and full load reactive power according to the load condition.

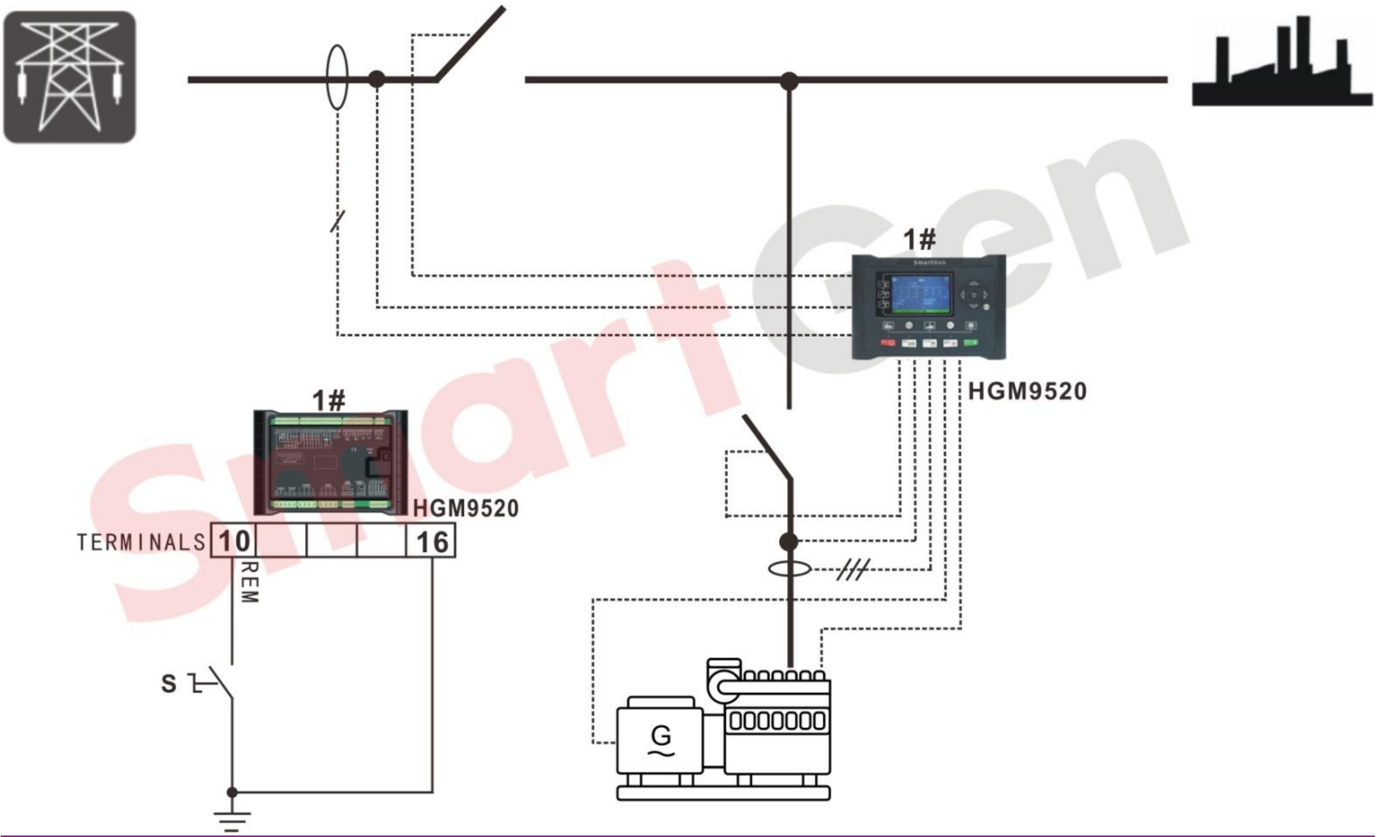


Fig.18 AMF control mode application

Table 19 AMF control mode application related parameters settings

Items	Parameters	Setting Values	Remark
Mains Settings	AC system	3P4W	
	Voltage	230V	
	Frequency	50Hz	
	CT primary	1500/5	
	Full load rating	800kW	
	Load kvar rating	600kvar	
	Mains decoupling	Enable: R.O.C.O.F, Vector Shift, Mains Under Voltage, Mains Over Voltage, Mains Under Frequency, Mains Over Frequency	
Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>	
	Rated speed	1500r/min	

Items	Parameters	Setting Values	Remark
	Crank disconnect conditions	Frequency + Speed	
Generator Settings	AC system	3P4W	
	Rated voltage	230V	
	Rated frequency	50Hz	
	CT primary	2000/5	CT selection＞full loading rated current
	Full load rating (rated current)	1620A	Full load rating=rated power × 1.8
	Full kW rating (rated kW power)	900kW	
	Full kvar rating (rated kvar power)	760kvar	Setting based on PF 0.8
Digital Inputs Settings	Digital input 4	Generator closed auxiliary	
	Digital input 8	Mains closed auxiliary	
Relay Outputs Settings	Relay output 5	Open gen output	
	Relay output 6	Close gen output	
	Relay output 3	Close Mains output	
	Relay output 4	Open Mains output	
Sync. Settings	MSC number	1	
Sync. Calibration	GOV/AVR	GOV: (SW1: 5; SW2: 2) AVR: (SW1: 0; SW2: 2)	Refer to <HGM9500 controller GOV/AVR parameter setting>

After above settings completed, controller is in AUTO mode, if Mains is faulty, MCB will open, Gen will take the load. If Mains is return, Mains will anti-synchronize with Gen and load will transfer from Gen to Mains, GCB will open, and then generator will stop.

Note: Load has no power supply after Mains faulty and before GCB close; load has continuous power from Mains return and Mains loaded.

1.4.9 Island Mode Application

The application is same as “Take Over” mode.

1.5 Economic Fuel Consumption Synchronization Application

1.5.1 Description of the economic fuel consumption synchronization application

Enable the economic fuel consumption to realize this function. Configure the same economic fuel consumption data for all gensets, including enable economic fuel consumption, economic fuel consumption percentage, and economic fuel consumption exchange rate.

Scheduling principle:

——The priority is to select minimum synchronizing gensets, when the one generator can meet with the requirements, the second genset will not start, and likewise.

——The second priority is to meet the economic fuel consumption percentage. The load percentage of the selected solution should not be greater than and closest to the economic fuel consumption percentage.

——When choose the better solution, the total rated power difference before and after exchange should greater than economic fuel consumption exchange rate.

——When enable the economic fuel consumption, the parameters including Call for more sets percentage, Call for less sets percentage, Call for more sets active power, Call for less sets active power, MSC number etc. are still work.

——Economic fuel consumption scheduling and balance time scheduling cannot work at the same time. When economic fuel consumption scheduling enabled, balance time scheduling will not work anymore.

1.5.2 Two gensets with different capacities running in synchronization

This solution selected with HGM9510N is suitable for two gensets with different power running in synchronization.

Example 11: Two EFI gensets, Gen 1 rated power is 300kW, Gen 2 rated power is 360kW, both two AVRs are MX321, and gensets are running in a fuel-efficient manner.

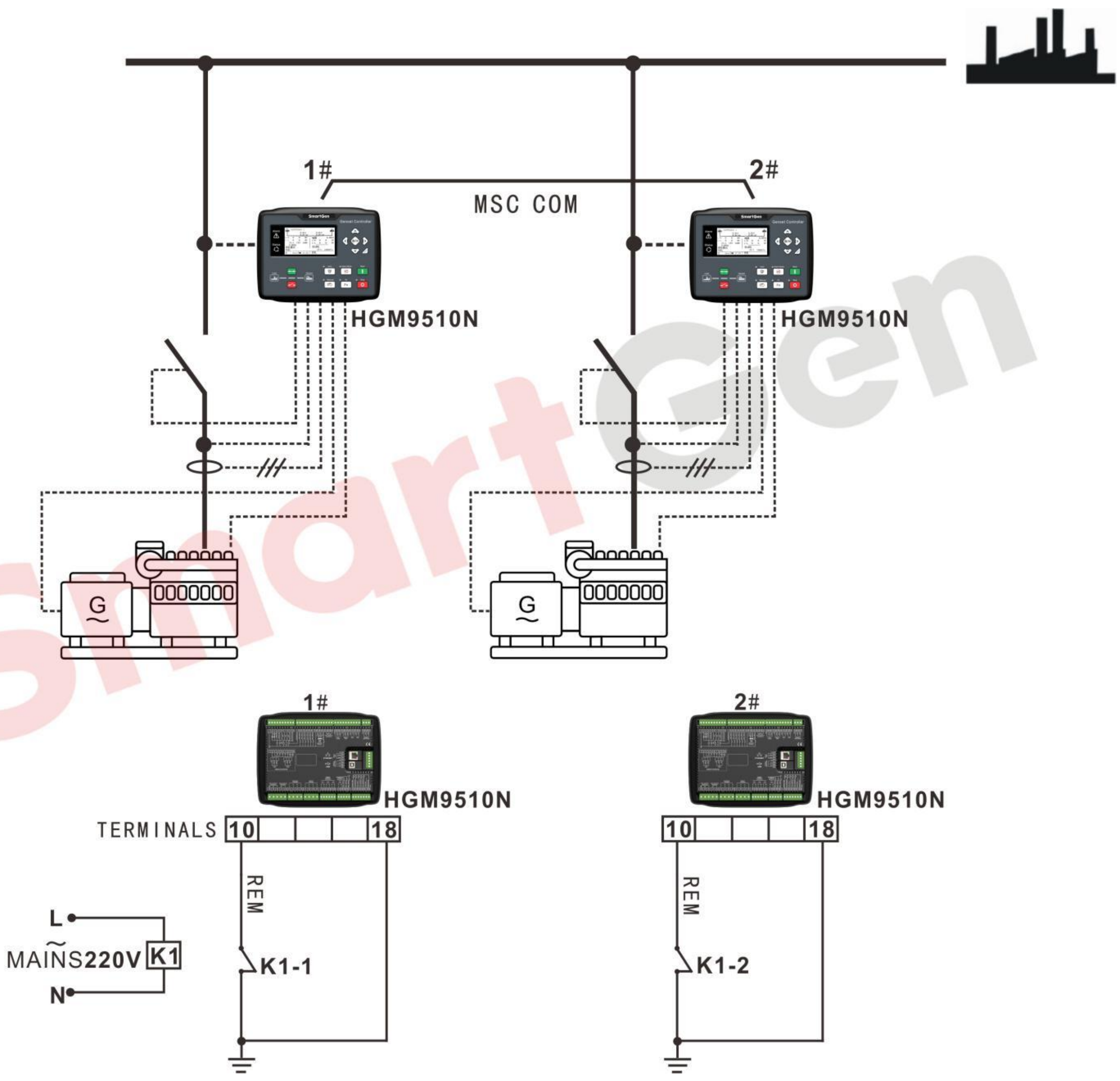


Fig.19 Two different power gensets synchronization diagram

Table 20 Two different power gensets synchronization related parameter settings

Items	Parameters	Setting Values		Remark
		Gen 1	Gen 2	
Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>		
	Rated speed	1500r/min		
	Crank disconnect conditions	Frequency + Speed		
Generator Settings	AC system	3P4W		
	Rated voltage	230V		
	Rated frequency	50Hz		

Items	Parameters	Setting Values Gen 1	Setting Values Gen 2	Remark
	CT primary	600/5	750/5	CT selection＞full loading rated current
	Full load rating (rated current)	540A	648A	Full load rating=rated power × 1.8
	Full kW rating (rated kW power)	300kW	360kW	
	Full kvar rating (rated kvar power)	222kvar	270kvar	Setting based on PF 0.8
Digital Inputs Settings	Digital input 1	Remote start(Start Sets as Load Require)		
	Digital input 4	Generator closed auxiliary		
Relay Outputs Settings	Relay output 5	Open gen output		
	Relay output 6	Close gen output		
Sync. Settings	MSC number	2		
	Starting option	Start sets as load require		
	Sets on Bus	1		The number of sets on bus means the minimum synchronizing gensets . If setting as 2, Gen1 and Gen2 will keep running in synchronization.
	Economy Fuel (%)	75%		
	Economy Sawp(W)	50kW		
	Call More Sets(%) (the maximum load percentage when to start the genset)	75%		1. Call more sets power = full load kW of current running genset×call more sets (%) 2. call more sets (%)=Call more sets power/ full load kW of current running genset
Sync. Calibration	(MSC)ID	1	2	
	Module Priority	1	2	
	GOV/AVR	GOV: SW1: 5; SW2: 2		Refer to <HGM9500N controller

Items	Parameters	Setting Values		Remark
		Gen 1	Gen 2	
		AVR: SW1: 0; SW2: 2		GOV/AVR parameter setting>

After above parameters set completely, the controller is in Auto Mode, remote start is active:

a) Gen 1 starts and takes the load.

b) When load power is 150kW, 50% of Gen 1 rated power, which is below economical fuel consumption 75%, Gen 1 will continue to take the load.

c) When the load power is above 225kW, and greater than 75% of the rated power of Gen1 (the percentage of economic fuel consumption setting limit), the optimal solution is as follows: Gen2 running in synchronization. Gen 1 rated power is 300kW, the optimal solution rated power is 360kW, since exchange power (300kW+50kW＜360kW) is not less than 50kW, Gen 2 will start to synchronize running and take the load, Gen 1 will soft unloading and top.

d) When the load power is above 270kW, and is greater than 75% of the rated power of Gen2 (the percentage of economic fuel consumption setting limit), the optimal solution is as follows: Gen2 +Gen1. The rated power of the original solution is 360kW, and the optimal solution rated power is 660kW, since exchange power (360kW+50kW＜300kW+360kW) is not less than 50kW, Gen1 and Gen2 will running in synchronization to share the load.

Note 1: we strongly suggest to configure the economical fuel consumption percentage and the calling for more sets percentage as the same limit.

Note 2: calling for more sets percentage is prior to exchange power conditions.

In this example, if configure the economical fuel consumption percentage as 75%, call for more sets set as 80%, exchange power set as 70kW(＞360kW-300kW), operation procedure is as follows:

Gen1 start to take the load.

When the load power is 150kW, which is 50% of Gen1 rated power and is less than setting economical consumption 75%, Gen1 will continue to take the load.

When the load power is above 225kW, and is greater than 75% of Gen1 rated power (the percentage of economic fuel consumption setting limit), the optimal solution is Gen2. However, since the rated power of Gen2(360kW) minus the rated power Gen1(300kW) is less than the exchange power of 70kW, the switching condition is not satisfied, so Gen1 continues to take the load.

When the load power is above 240kW, the optimal solution is still Gen2(the load power is less than 75% of Gen2 rated power, 270kW). However, since the load power is greater than the 80% calling for more sets rate of Gen1, which cause the exchange power condition limit invalid, and the Gen2 is powered on and running in synchronization to take the load, and then the Gen1 is soft-unloaded and shut down.

When the load power is above 270kW, and is greater than 75% of Gen2 rated power (the percentage of economic fuel consumption setting limit), the optimal solution is Gen2 + Gen1. Since the rated power of Gen2(360kW) plus 70kW (equal to 430kW) is greater than the exchange power of 70kW(360kW+70kW＜360kW+300kW), which is meet the switching condition, so Gen1 and Gen2 will take the load together.

When the load power is below 270kW, it is lower than 360kW × 75%(270kW, the percentage of economic fuel consumption setting limit), and meet the switching condition(660kW-360kW＞70kW). The optimal solution is Gen2, and Gen1 will soft-unload and shutdown.

When the load power is below 225kW, it is lower than 300kW × 75%(225kW, the percentage of economic fuel consumption setting limit), and cannot meet the switching condition 70kW(360kW-300kW＜70kW). Thus, Gen2 continues to take the load.

Gen2 is loaded until remote start signal is invalid.

1.5.3 Multi different capacities gensets running in synchronization.

This solution is suitable for multi different capacities gensets synchronized running in “Economical fuel consumption” mode, and use HGM9510N controllers.

Example 10: 4 EFI gensets, rated power of Gen1 is 100kW, Gen2 is 200kW, Gen 3 is 360kW, and Gen4 is 360kW. The AVR model of these four gensets is MX321, and gensets are taking load based on economical fuel consumption mode.

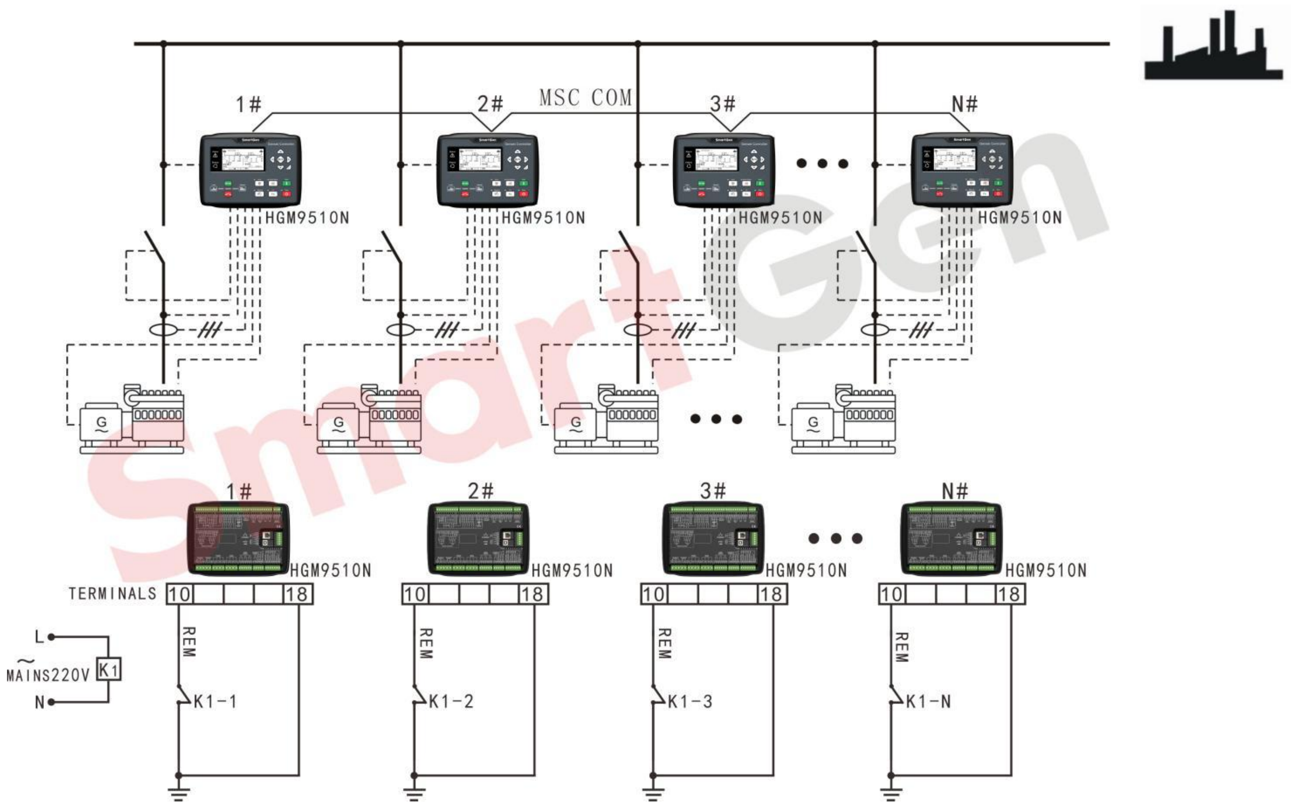


Fig. 20 multi different capacities gensets synchronized in "economical fuel consumption" mode diagram

Table 21 Four different capacities gensets synchronized in "economical fuel consumption" parameter settings

Items	Parameters	Setting Values				Remark
		Gen1	Gen2	Gen3	Gen4	
Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>				
	Rated speed	1500r/min				
	Crank disconnect conditions	Frequency + Speed				
Generator Settings	AC system	3P4W				
	Rated voltage	230V				
	Rated frequency	50Hz				
	CT primary	250/5	400/5	630/5	630/5	
	Full load rating (rated current)	180A	360A	648A	648A	
	Full kW rating	100kW	200kW	360kW	360kW	

<table>
<tr><th rowspan="2">Items</th><th rowspan="2">Parameters</th><th colspan="4">Setting Values</th><th rowspan="2">Remark</th></tr>
<tr><th>Gen1</th><th>Gen2</th><th>Gen3</th><th>Gen4</th></tr>
<tr><td rowspan="2"></td><td>(rated kW power)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Full kvar rating (rated kvar power)</td><td>75kvar</td><td>150kvar</td><td>270kvar</td><td>270kvar</td><td>Setting based on PF 0.8</td></tr>
<tr><td rowspan="2">Digital Inputs Settings</td><td>Digital input 1</td><td colspan="4">Remote start(Start Sets as Load Require)</td><td></td></tr>
<tr><td>Digital input 4</td><td colspan="4">Generator closed auxiliary</td><td></td></tr>
<tr><td rowspan="2">Relay Outputs Settings</td><td>Relay output 5</td><td colspan="4">Mains open auxiliary</td><td></td></tr>
<tr><td>Relay output 6</td><td colspan="4">Mains closed auxiliary</td><td></td></tr>
<tr><td rowspan="6">Sync. Settings</td><td>MSC number</td><td colspan="4">4</td><td></td></tr>
<tr><td>Starting option</td><td colspan="4">Start sets as load require</td><td></td></tr>
<tr><td>Sets on Bus</td><td colspan="4">1</td><td>The number of sets on bus means the minimum synchronizing gensets . If setting as 4, all gensets will start and running.</td></tr>
<tr><td>Economy Fuel (%)</td><td colspan="4">75%</td><td></td></tr>
<tr><td>Economy Sawp(W)</td><td colspan="4">50kW</td><td></td></tr>
<tr><td>Call More Sets(%) (the maximum load percentage when to start the genset)</td><td colspan="4">75%</td><td>1. Call more sets power = full load kW of current N synchronizing gensets ×call more sets (%)
2. call more sets (%)=call more sets power/ full loading power of N synchronizing gensets.
⚠ Note: “N” means the number of synchronized gensets. In this example, when N=1, the Gen2 will start, when N=2, the Gen3 will start, and</td></tr>
</table>

Items	Parameters	Setting Values				Remark
		Gen1	Gen2	Gen3	Gen4	
						when N=3, the Gen4 will start.
Sync. Calibration	(MSC)ID	1	2	3	4	
	Module Priority	1	2	3	4	
	GOV/AVR	GOV: (SW1: 5; SW2: 2) AVR: (SW1: 0; SW2: 2)				Refer to <HGM9500N controller GOV/AVR parameter setting>

After above parameters completed, controller is in AUTO mode, and when remote start input is active:

a) Gen1 starts and takes the load.

b) When load power is above 75kW, and is greater than 75% of the Gen1 rated power (the percentage of economic fuel consumption setting limit), the optimal solution is Gen2. Gen1 rated power is 100kW, and Gen2 rated power is 200kW, since the exchange power (100kW+50kW＜200kW) is not lower than 50kW, the Gen2 starts and runs in synchronization to take the load, and Gen1 soft unloads and stops.

c) When the load power is above 150kW, and is greater than 75% of the Gen2 rated power (the percentage of economic fuel consumption setting limit), the optimal solution is Gen3(Gen3 has a higher priority than Gen4). Gen2 rated power is 200kW, and Gen3 rated power is 360kW, since the exchange power (200kW+50kW＜360kW) is not lower than 50kW, the Gen3 starts and runs in synchronization to take the load, and Gen2 soft unloads and stops.

d) When the load power is above 270kW, and is greater than 75% of the Gen3 rated power (the percentage of economic fuel consumption setting limit), the optimal solution is Gen3+Gen1. Gen3 rated power is 360kW, and Gen1 rated power is 100kW, since the exchange power (100kW+360kW＞360kW+50kW) is not lower than 50kW, the Gen1 starts and runs in synchronization with Gen3 to share the load.

e) When the load power is above 345kW, the optimal solution is Gen3 and Gen2 run in synchronization and share the load, and Gen1 soft unloads and stops.

f) When the load power is above 420kW, the optimal solution is Gen3 and Gen4 run in synchronization and share the load, and Gen2 soft unloads and stops.

g) When the load power is above 540kW, the optimal solution is Gen3, Gen4 and Gen1 run in synchronization and share the load.

h) When the load power is above 615kW, the optimal solution is Gen3, Gen4 and Gen2 run in synchronization and share the load, and Gen1 soft unloads and stops.

i) When the load power is above 690kW, the optimal solution is all the gensets start and share the load.

Note 1: we strongly suggest to configure the economical fuel consumption percentage and the calling for more sets percentage as the same limit.

Note 2: calling for more sets percentage is prior to exchange power conditions.

1.6 Other Modes Application

1.6.1 Power Management Mode

This solution is suitable for transformation of multiple non-synchronous gensets, adding HGM9510 or HGM9510N to achieve multiple gensets running in synchronization and power sharing. Application occasions: transformation of multiple single start genset to synchronization.

Example 20: There are four 360kW EFI gensets with SX440 AVR, and transform these four gensets to realize synchronous running and evenly share the load without changing the original control system.

Use the power management mode of four HGM9510 controllers to realize the power distribution based on the requirement.

Note:

Application abstract of power management:

- HGM9510 configurable relay output(passive contact) can be set as fuel output, which is connect to remote start input REM and E of the genset controller.
- HGM9510 crank disconnect conditions select as “Frequency”.
- HGM9510 input port is configured as “Emergency Stop”, and expand a DC24V replay, and its normally open contact connects with the HGM6110N input port(external shutdown alarm input) to realize emergency shutdown in two places.
- Connect the passive contact of the configurable output port of the genset controller to the configurable input port (user-defined as shutdown alarm input)of the HGM9510 to realize that if there’s shutdown alarm in two places, genset can shut down.
- HGM9510 configurable input port configured as “Power Management Mode”, open to activate.

- HGM9510 wring connection: B+, B-, FUEL, EMERGENCY STOP, CLOSE GEN OUTPUT, OPEN GEN OUTPUT, GOV, AVR, MSC, SPEED, GENERATOR CLOSED AUXILIARY, SHUTDOWN ALARM INPUT, SAMPLING VOLTAGE, SAMPLING BUSBARM SAMPLING CURRENT.
- Wring connection of the controller besides of the genset: B+, B-, FUEL, CRANK, WATER TEMPERATURE, OIL PRESSURE, SPEED, SAMPLING VOLTAGE, SAMPLING CURRENT, SHUTDOWN ALARM OUTPUT, EXTERNAL SHUTDOWN ALARM INPUT, REMOTE START INPUT, IDLING CONTROL OUTPUT.
- Configure water temperature and oil pressure sensor curves as “Not Used”.
- There is no need to configure the “Cooling Time” and “Stop Idle Time”, but the “Fail to Stop Delay” should be greater than or equal to the sum of the “Cooling Time” + “ Idle Stopping Time” of the side controller, so that to avoid HGM9510 displays shutdown failure. There is no need to set “Start Idle Time” of HGM9510, and the “Warming Up time” should greater than that of the side controller.

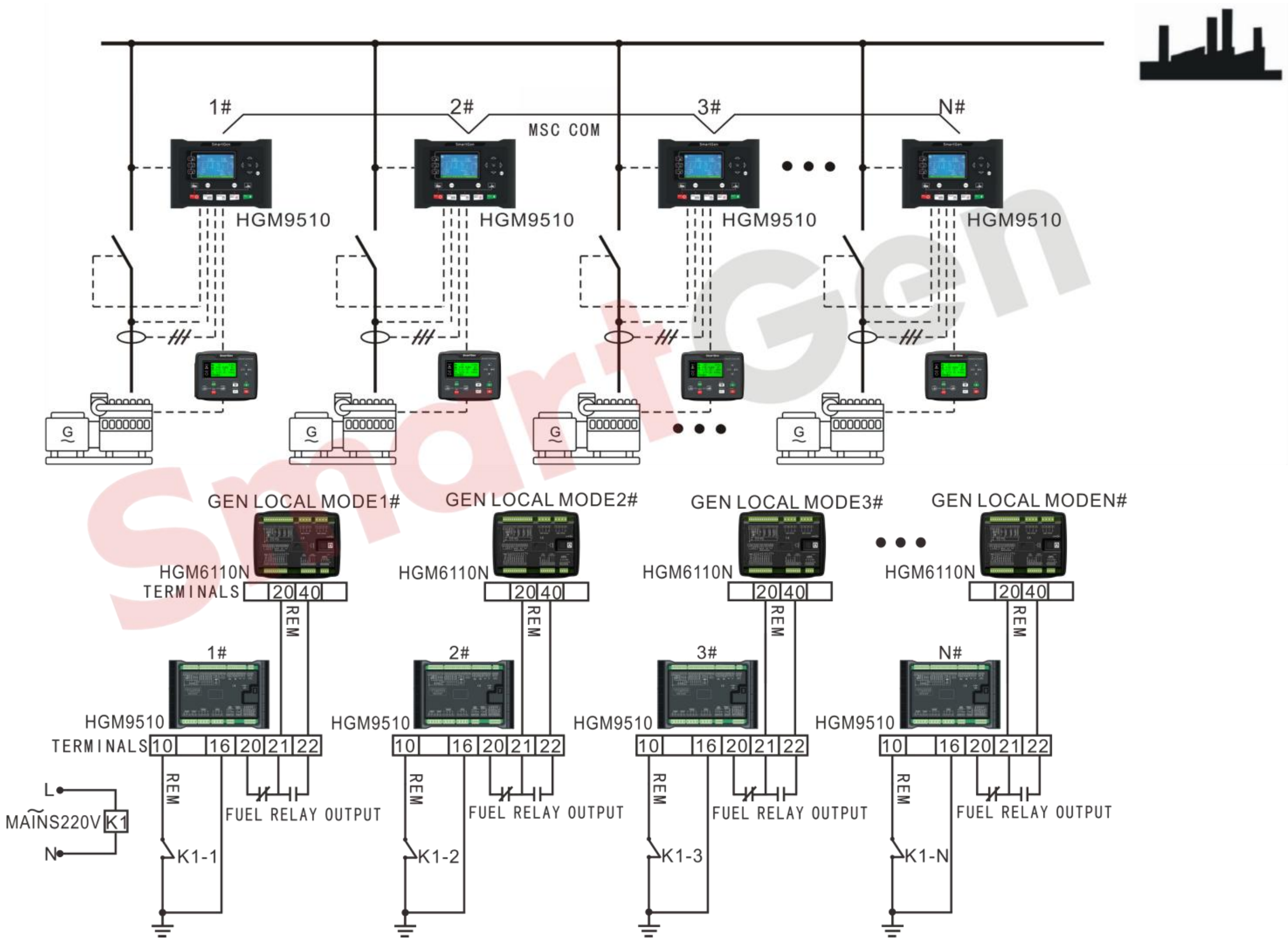


Fig. 21 Power management application diagram

Table 22 Power management application parameters settings

Items	Parameters	Setting Values				Remark
		Gen1	Gen2	Gen3	Gen4	
Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>				
	Rated speed	1500r/min				
	Crank disconnect conditions	Frequency				
Generator Settings	AC system	3P4W				
	Rated voltage	230V				
	Rated frequency	50Hz				
	CT primary	750/5				CT primary selection＞full load rated current
	Full load rating (rated current)	648A				Full load rated current=rated power×1.8
	Full kW rating (rated kW power)	360kW				
	Full kvar rating (rated kvar power)	274kvar				Setting based on PF 0.8
Digital Inputs Settings	Digital input 1	Remote start(Start Sets as Load Require)				
	Digital input 2	User-defined				Setting as "Alarm Stop" input, close to activate, alarm shutdown, always active, and then connect to the passive normally open contact of the controller on the genset, and configure it as "Alarm Stop" output.
	Digital input 4	Gen close auxiliary				
	Digital input 5	Power management mode				Open to activate
Relay Outputs Settings	Relay output 3	Emergency stop output				A DC24V relay needs to be expanded, and its normally open contact connects with the genset controller input port(external shutdown

Items	Parameters	Setting Values				Remark
		Gen1	Gen2	Gen3	Gen4	
						alarm input) to realize emergency shutdown in two places.
	Relay output 4	Fuel relay output				A DC24V relay needs to be expanded if using active fuel output. Connect the passive normally open contact with the remote start signal of the genset controller.
	Relay output 5	Open gen output				
	Relay output 6	Close gen output				
Sync. Settings	MSC number	4				
	Starting option	Start sets as load require				
	Calling for More Sets(%) (the maximum load percentage when to start the genset)	80%				1. Call more sets power = full load kW of current N synchronizing gensets× call more sets (%) 2. call more sets (%)=call more sets power/ full loading power of N synchronizing gensets. **Note: "N" means the number of synchronized gensets.** **In this example, when N=1, the Gen2 will start, when N=2, the Gen3 will start, and when N=3, the Gen4 will start.**
	Calling for less sets(the maximum load percentage when to stop the genset)	40%				1. Call less sets power = full load kW of current N synchronizing gensets x$\frac{(N-1)}{N}$ × call less sets (%)

Items	Parameters	Setting Values				Remark
		Gen1	Gen2	Gen3	Gen4	
						2.Call less sets (%)=Call less sets power/ full load kW of current N synchronizing gensets x$\frac{N}{(N-1)}$ **Note: "1" in the formula means the genset with the lowest priority that will be called for stopped; "N" means the number of synchronized gensets.** **In this example, when N=4, the Gen4 will stop, when N=3, the Gen3 will stop, and when N=2, the Gen2 will stop.** **Note: calling for less sets power means the load power.** **Note: if there are many genset running in synchronization, it is recommended to reduce the percentage of calling for less sets to avoid frequent start and shutdown of gensets.**
Sync. Calibration	(MSC)ID	1	2	3	4	
	Module Priority	1	2	3	4	
	GOV/AVR	GOV: (SW1: 5; SW2: 2) AVR: (SW1: 0; SW2: 2)				Refer to <HGM9500 controller GOV/AVR parameter setting>

After above parameters configured completely, HGM9510 works in auto mode, and power management mode is active, when the remote start input signal is active, fuel relay of HGM9510 will output. The passive

normally open contact of the relay is used to control the remote start of the side controller (in auto mode), and the Gen1 starts with load. If the current load power≥power when calling for more sets 288kW, Gen2 will start and synchronize with the Busbar to share the load.

If the current load power ≥ calling for more sets power 576kW, Gen3 will start and synchronize with the busbar, and three gensets will share the current load power evenly; if the current load power ≥ calling for more sets power 864kW, Gen4 will start and synchronize with the busbar, and four gensets will share the current load power evenly.

If the current load power < calling for less sets power 432kW, Gen4 will stop, and three gensets will share the load power evenly; if the current load power < calling for less sets power 288kW, Gen3 will stop, and two gensets will share the load power evenly; if the current load power < call for less sets power 144kW, Gen2 will stop, and only one genset will take the load.

Note:

- The first HGM9510 is added with Mains failure start signal(remote start relay), and the start signal of the remaining HGM9510 controllers are synchronized, when the genset side controller manually start, HGM9510 should in auto mode; when the HGM9510 start(no matter in auto or manual mode), genset side controller should in auto mode, or both controllers are in auto mode.
- After power management mode is active, HGM9510 doesnllers are in auto mode. 510 stagenset warmed up in high speed, HGM9510 enters high speed delay.
- When there is an output breaker connected with genset side controller, the breaker should be in the closed state.

Note: when the genset side controller has a long distance with the synchronized controller, a remote start relay needs to be expanded.

1.6.2 Busbar synchronization

This solution is suitable for applications where multiple gensets can be loaded in groups or by a single genset. HGM9510 controller or HGM9510N+HGM9580 controllers can be selected, and applications are: factories, buildings, etc.

Example 21: Four 350kW EIF gensets with SX440 AVR, and the busbar divided into two groups(one group include two gensets), and start/stop the other three gensets according to the load requirement.

Note: chose 4 × HGM9510 synchronize controller and 1 × HGM9580 bus-bus synchronize controller based on the requirement.

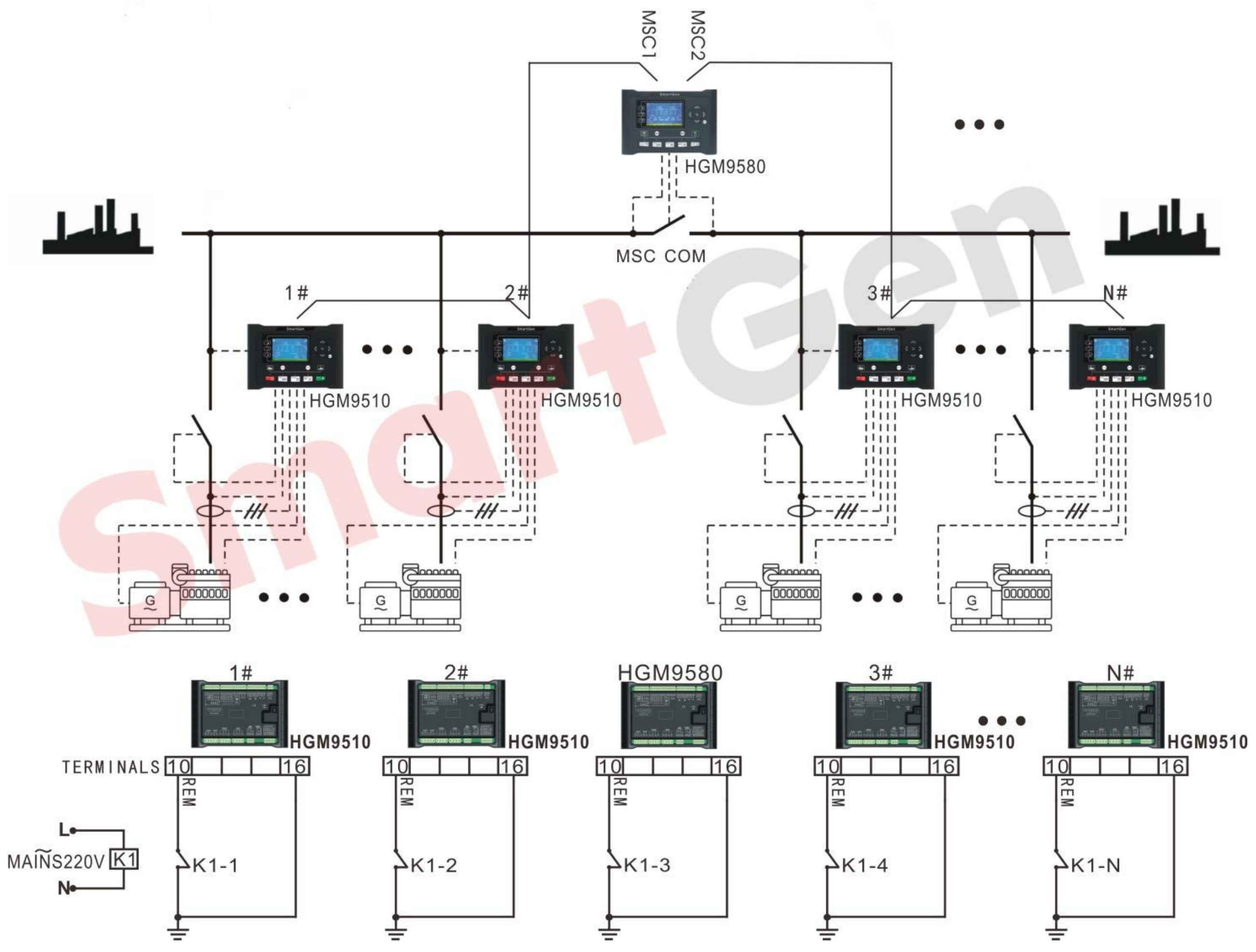


Fig. 22 Bus-Bus synchronization diagram

Table 23 Bus-Bus synchronization parameters settings

Items	Parameters	Setting Values				Remark
		Gen1	Gen2	Gen3	Gen4	
HGM9510 Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>				
	Rated speed	1500r/min				
	Crank disconnect conditions	Frequency + Speed				
HGM9510 Generator Settings	AC system	3P4W				
	Rated voltage	230V				
	Rated frequency	50Hz				

<table>
<tr><th rowspan="2">Items</th><th rowspan="2">Parameters</th><th colspan="4">Setting Values</th><th rowspan="2">Remark</th></tr>
<tr><th>Gen1</th><th>Gen2</th><th>Gen3</th><th>Gen4</th></tr>
<tr><td rowspan="4"></td><td>CT primary</td><td colspan="4">750/5</td><td>CT primary selection＞ full load rated current</td></tr>
<tr><td>Full load rating (rated current)</td><td colspan="4">630A</td><td>Full load rated current=rated power× 1.8</td></tr>
<tr><td>Full kW rating (rated kW power)</td><td colspan="4">350kW</td><td></td></tr>
<tr><td>Full kvar rating (rated kvar power)</td><td colspan="4">260kvar</td><td>Setting based on PF 0.8</td></tr>
<tr><td rowspan="2">HGM9510 Digital Inputs Settings</td><td>Digital input 1</td><td colspan="4">Remote start(Start Sets as Load Require)</td><td></td></tr>
<tr><td>Digital input 4</td><td colspan="4">Gen close auxiliary</td><td></td></tr>
<tr><td rowspan="2">HGM9510 Relay Outputs Settings</td><td>Relay output 5</td><td colspan="4">Open gen output</td><td></td></tr>
<tr><td>Relay output 6</td><td colspan="4">Close gen output</td><td></td></tr>
<tr><td rowspan="3">HGM9510 Sync. Settings</td><td>MSC number</td><td colspan="4">4</td><td></td></tr>
<tr><td>Starting option</td><td colspan="4">Start sets as load require</td><td></td></tr>
<tr><td>Calling for More Sets(%) (the maximum load percentage when to start the genset)</td><td colspan="4">80%</td><td>1. Call more sets power = full load kW of current N synchronizing gensets × call more sets (%)
2. call more sets (%)=call more sets power/ full load kW of current N synchronizing gensets.
Note: “N” means the number of synchronized gensets. In this example, when N=1, the Gen2 will start, when N=2, the Gen3 will start, and when N=3, the Gen4</td></tr>
</table>

Items	Parameters	Setting Values				Remark
		Gen1	Gen2	Gen3	Gen4	
						will start.
	Calling for less sets(the maximum load percentage when to stop the genset)	40%				1. Call less sets power = full load kW of current N synchronizing gensets x$\frac{(N-1)}{N}$ ×call less sets (%) 2.Call less sets (%)=Call less sets power/ full load kW of current N synchronizing gensets x$\frac{N}{(N-1)}$ **Note: "1" in the formula means the genset with the lowest priority that will be called for stopped; "N" means the number of synchronized gensets.** **In this example, when N=4, the Gen4 will stop, when N=3, the Gen3 will stop, and when N=2, the Gen2 will stop.** **Note: calling for less sets power means the load power.** **Note: if there are many genset running in synchronization, it is recommended to reduce the percentage**

Items	Parameters	Setting Values				Remark
		Gen1	Gen2	Gen3	Gen4	
						of calling for less sets to avoid frequent start and shutdown of gensets.
HGM9510 Sync. Calibration	(MSC)ID	1	2	3	4	
	Module Priority	1	2	3	4	
	GOV/AVR	GOV: (SW1: 5; SW2: 2) AVR: (SW1: 0; SW2: 2)				Refer to <HGM9500 controller GOV/AVR parameter setting>
HGM9580 Bus Settings	AC System	3P4W				
HGM9580 Digital Inputs	Digital input 1	Remote Close On-load				
	Digital input 4	Bus Closed Auxiliary				
HGM9580 Relay Outputs	Relay output 5	Open Bus Output				
	Relay output 6	Close Bus Output				
HGM9580 Sync Settings	MSC Number	2				
	Control Prior	Bus 1				
	MSC1/2 Level	Same Level				
HGM9580 Sync Calibration	MSC ID	1				

If above parameters set completely, before close bus tie breaker, the two sections of busbars are independent, and each section of busbars independently performs power sharing and gensets scheduling; after close bus tie breaker, the two sections of the busbar equally share the power, and no genset scheduling is performed, and the four gensets are manually turned on/off.

There are 4 units of HGM9510 controllers used in this project, when remote start input is active, and HGM9580 under manual mode, Gen1 will start and supply power for the load1; if the current power of load1 ≥calling for more set power 280kW, Gen2 will start and synchronize with Gen1, and two gensets will share the load1 evenly; and Gen3 will start and supply power for Load2; if the current power of load2 ≥calling for more set power 280kW, Gen4 will start and synchronize with Gen3, and two gensets will share the load2 evenly; If either channel of load power ≥80% of the corresponding busbar power, the bus tie breaker need to be closed manually through HGM9580, and four gensets will share the current load evenly.

If the current power of the load < calling for less sets power 420kW, Gen4 will unload and stop, and the left three gensets will share the load evenly; if the current power of the load < calling for less sets power 280kW, Gen3 will unload and stop, and the two gensets of the first segment busbar share the current load power equally; if the current power of the load < calling for less sets power 140kW, Gen2 will unload and stop, and Gen1 will take the load.

Note: Theoretically, unlimited gensets can synchronize running through the HGM9580 controllers, it is can be realized according to the method of adding HGM9580 controller to control the multi-gensets grouping.

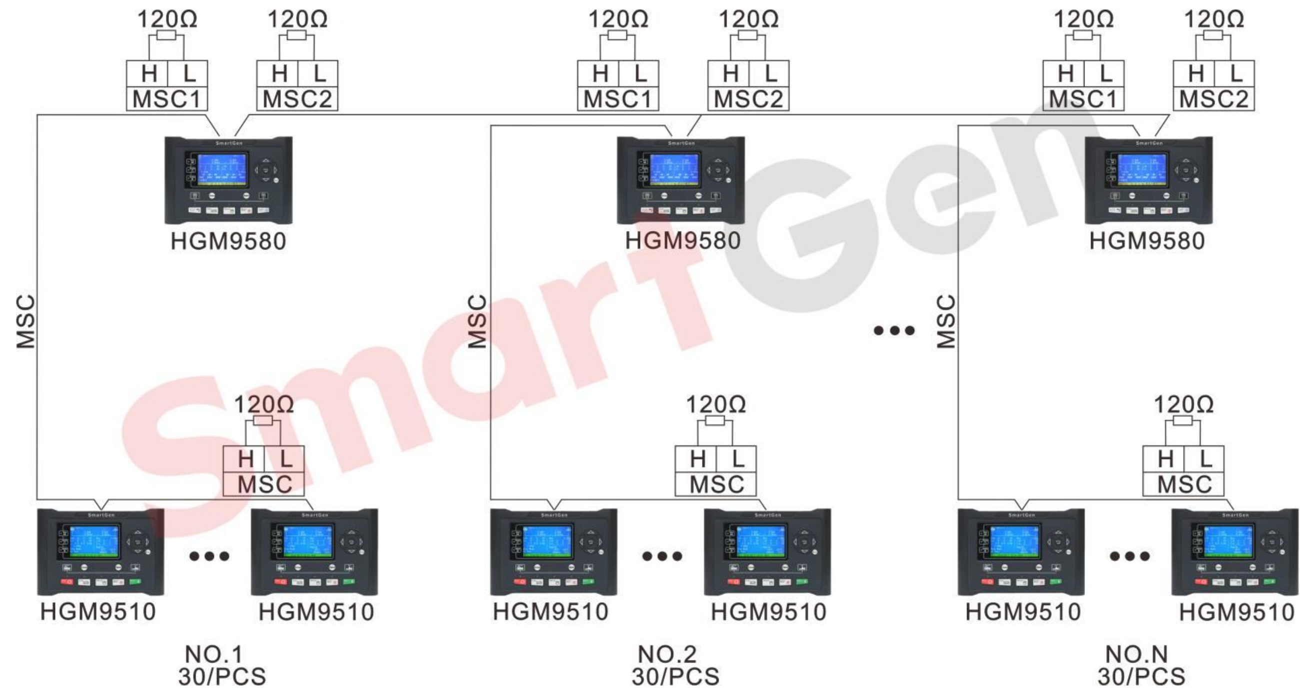


Fig. 23 Multiple groups of busbar synchronization diagram

1.6.3 EFI/Non-EFI gensets synchronization

This solution is suitable for EFI gensets synchronized with non-EFI genset under “Start Sets Under Load Require”. HGM9510 or HGM9510N controllers can be selected, and applicate to occasions when EFI gensets and non-EFI gensets running in synchronization.

Example 22: There are two gensets need running in synchronization, Gen1 is 880kW EFI genset, and Gen2 is 880kW non-EFI genset, AVR model is SX440, and non-EFI genset GOV model is ESD5500. One genset needs to start and take on load firstly, and then another genset needs to start/stop based on the load requirement.

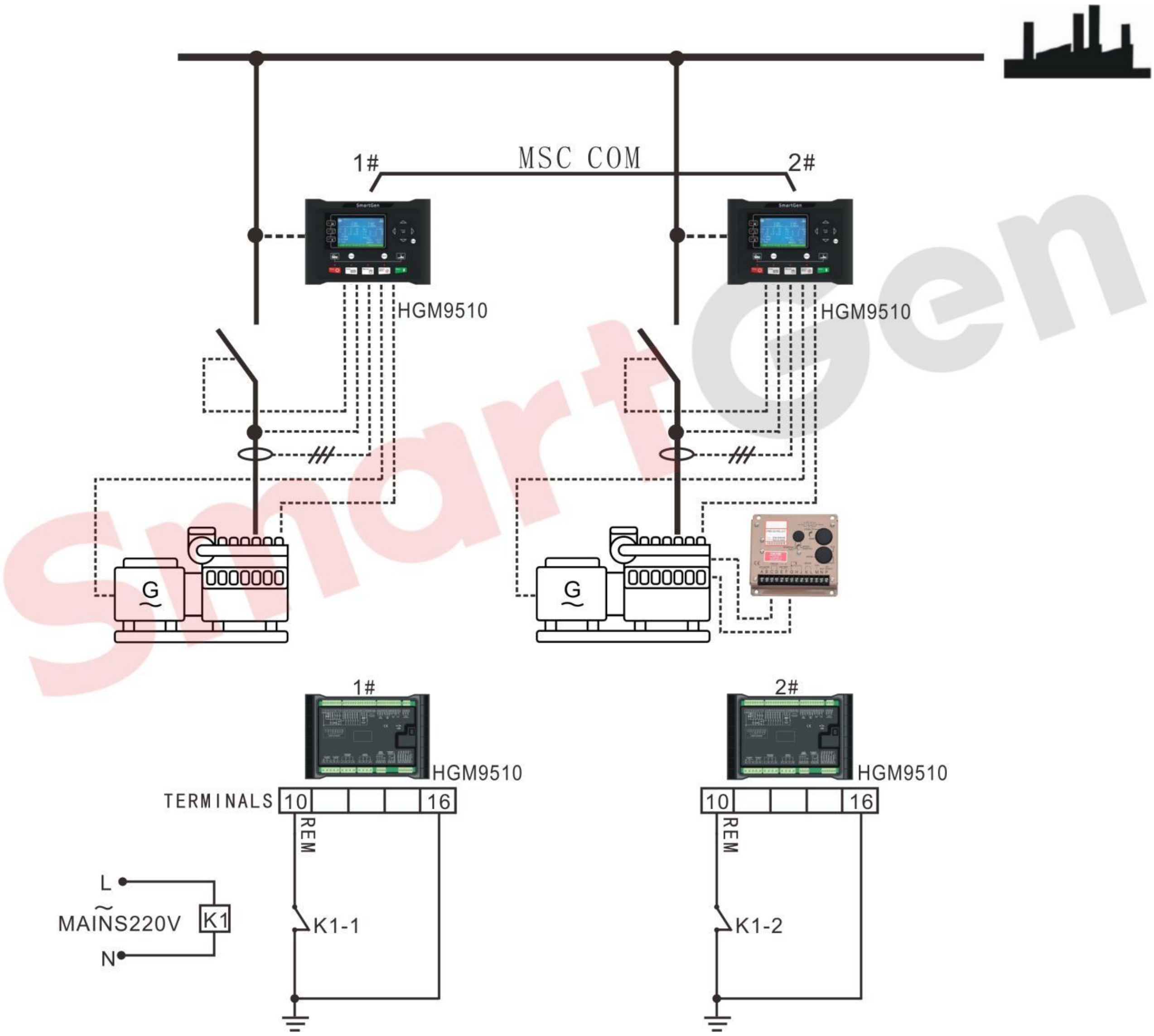


Fig. 24 Synchronization application diagram of two EFI/non-EFI genset gensets with same capacity

Table 24 Parameters of synchronization application of two EFI/non-EFI genset gensets with same capacity

Items	Parameters	Setting Values		Remark
		Gen1	Gen2	
Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>	Non-EFI genset	
	Flywheel teeth		Set based on the calculation result of the	Four-pole motor: Engine teeth=

Items	Parameters	Setting Values		Remark
		Gen1	Gen2	
			formula of the number of the engine flywheel teeth	$\left(\frac{\text{current speed}}{60} \times \frac{\text{preset teeth}}{\text{current frequency}}\right) \times 2$ **Note: "60" means 60s.**
	Rated speed	1500r/min		
	Crank disconnect conditions	Frequency + Speed		
Generator Settings	AC system	3P4W		
	Rated voltage	230V		
	Rated frequency	50Hz		
	CT primary	2000/5		CT primary selection＞full load rated current
	Full load rating (rated current)	1584A		Full load rated current=rated power×1.8
	Full kW rating (rated kW power)	880kW		
	Full kvar rating (rated kvar power)	670kvar		Setting based on PF 0.8
Digital Inputs Settings	Digital input 1	Remote start(Start Sets as Load Require)		
	Digital input 4	Gen close auxiliary		
Relay Outputs Settings	Relay output 5	Open gen output		
	Relay output 6	Close gen output		
Sync. Settings	MSC number	2		
	Starting option	Start sets as load require		
	Calling for More Sets(%) (the maximum load percentage when to start the genset)	80%		1. Call more sets power = full load kW of current N synchronizing gensets × call more sets (%) 2. call more sets (%)=call more sets power/ full load kW of current N synchronizing gensets.

Items	Parameters	Setting Values		Remark
		Gen1	Gen2	
				Note: "N" means the number of synchronized gensets. **In this example, N=1.**
	Calling for less sets(the maximum load percentage when to stop the genset)	40%		1. Call less sets power = full load kW of current N synchronizing gensets x$\frac{(N-1)}{N}$ ×call less sets (%) 2.Call less sets (%)=Call less sets power/ full load kW of current N synchronizing gensets x$\frac{N}{(N-1)}$ **Note: "1" in the formula means the genset with the lowest priority that will be called for stopped; "N" means the number of synchronized gensets.** **In this example, when N=4, the Gen4 will stop, when N=3, the Gen3 will stop, and when N=2, the Gen2 will stop.** **In this example, N=2.** **Note: calling for less sets power means the load power.**
Sync. Calibration	(MSC)ID	1	2	
	Module Priority	1	2	
	GOV/AVR	GOV: SW1: 5 SW2: 2	GOV: SW1: 9 SW2: 2	Refer to <HGM9500 controller GOV/AVR parameter setting>
		AVR: (SW1: 0; SW2: 2)		

After above parameters set completely, when the controller in auto mode, and remote start signal is active,

Gen1 will start and take load. If the current load power is greater than calling for more sets power 704kW, Gen2 will start and synchronized with Gen1 to share the load evenly. If the current load power is lower than calling for less set power 352kW, Gen2 will take of load and stop.

1.6.4 Black start

This solution is suitable for when a single genset starts, close generator output is active at the same time, the control switch is closed, and the generator switch selects the DC power switch. HGM9510 or HGM9510N controller can be selected to use in applications including power plants, factories, etc.

Note: Users can select one digital input port as "Black Start Input" function.

Example 23: There is one unit of 1200kW EFI genset with DVR2000E generator voltage regulator, before starting the genset, the generator switch is closed first, and supply power to the transformer.

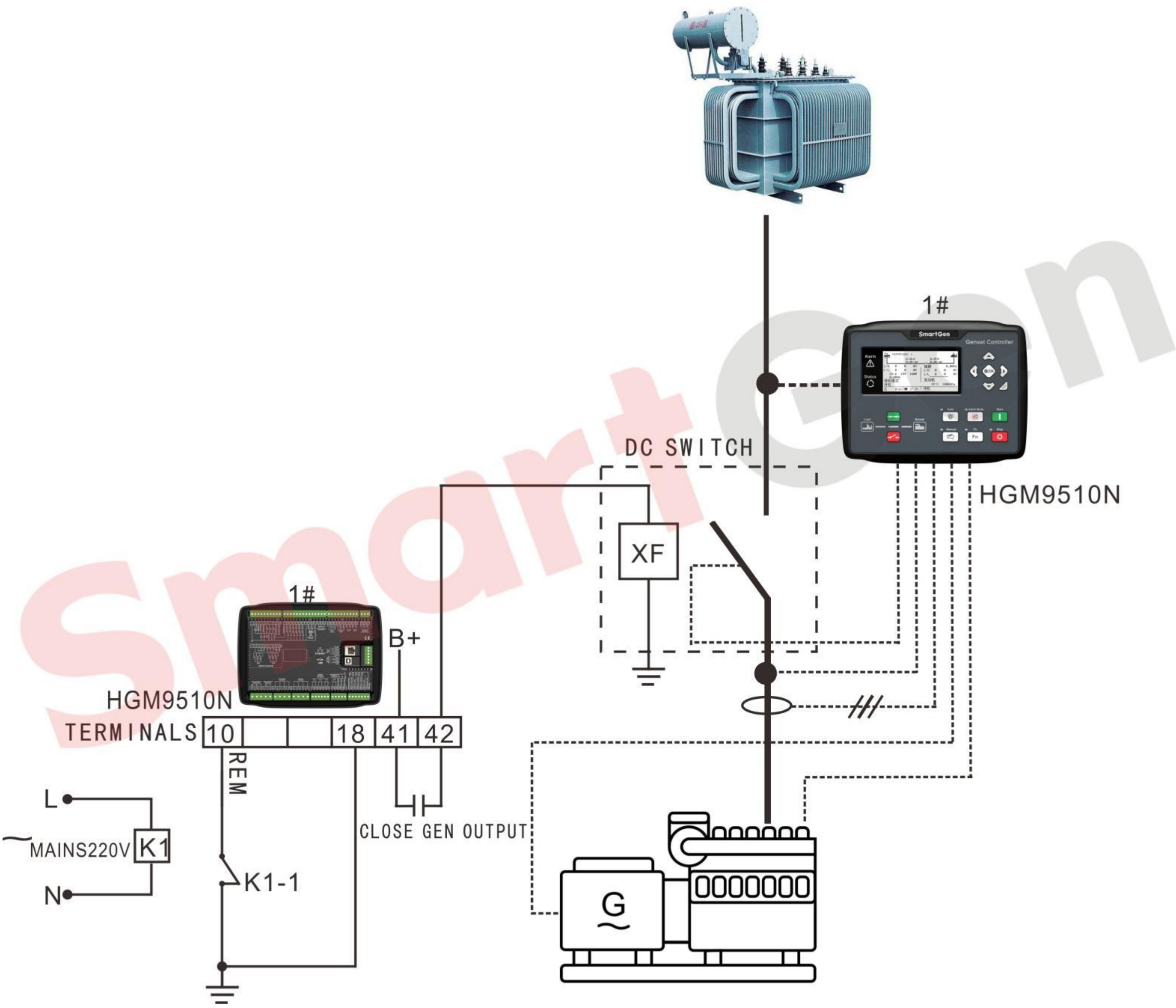


Fig. 25 Black start application diagram

Table 25 Black start parameters settings

Items	Parameters	Setting Values	Remark
Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>	
	Rated speed	1500r/min	
	Crank disconnect conditions	Frequency + Speed	
Generator Settings	AC system	3P4W	
	Rated voltage	230V	
	Rated frequency	50Hz	

Items	Parameters	Setting Values	Remark
	CT primary	2500/5	CT primary selection＞full load rated current
	Full load rating (rated current)	2160A	Full load rated current=rated power×1.8
	Full kW rating (rated kW power)	1200kW	
	Full kvar rating (rated kvar power)	888kvar	Setting based on PF 0.8
Digital Inputs Settings	Digital input 1	Remote start(Start Sets as Load Require)	
	Digital input 4	Gen close auxiliary	
	Digital input 5	Black start input	Always active. (HGM9510 PC software has no this option, users can select this option from controller screen; HGM9510N PC software has this option.)
Relay Outputs Settings	Relay output 5	Open gen output	
	Relay output 6	Close gen output	
Sync. Settings	MSC number	1	
Sync. Calibration	MSC ID	1	
	Module Priority	1	
	GOV/AVR	GOV: (SW1: 9; SW2: 2) AVR: (SW1: 0; SW2: 2)	Refer to <HGM9500N controller GOV/AVR parameter setting>

After above parameters set completely, when the controller in auto mode, and black start input is active, remote start input is active, the controller will close generator switch and generator starts up, and supply power to the transformer. When the remote start input is deactivated, generator switch will open and generator will top.

1.6.5 Central monitoring (HMU15) application

This solution is suitable for remote monitoring of up to 6xHGM9510 controllers to realize automatic start/stop gensets, data measurement, alarm display, switch closing and opening, and "four remote" functions. HGM9510 or HGM9510N controller can be selected to use in applications including power plants, centralized control center, etc.

Example 24: There are 6×600kW EFI gensets with AVR SX440 need to be monitored remotely, uses

can select HMU15 or HGM9510 to start/stop gensets, or close/open switch.

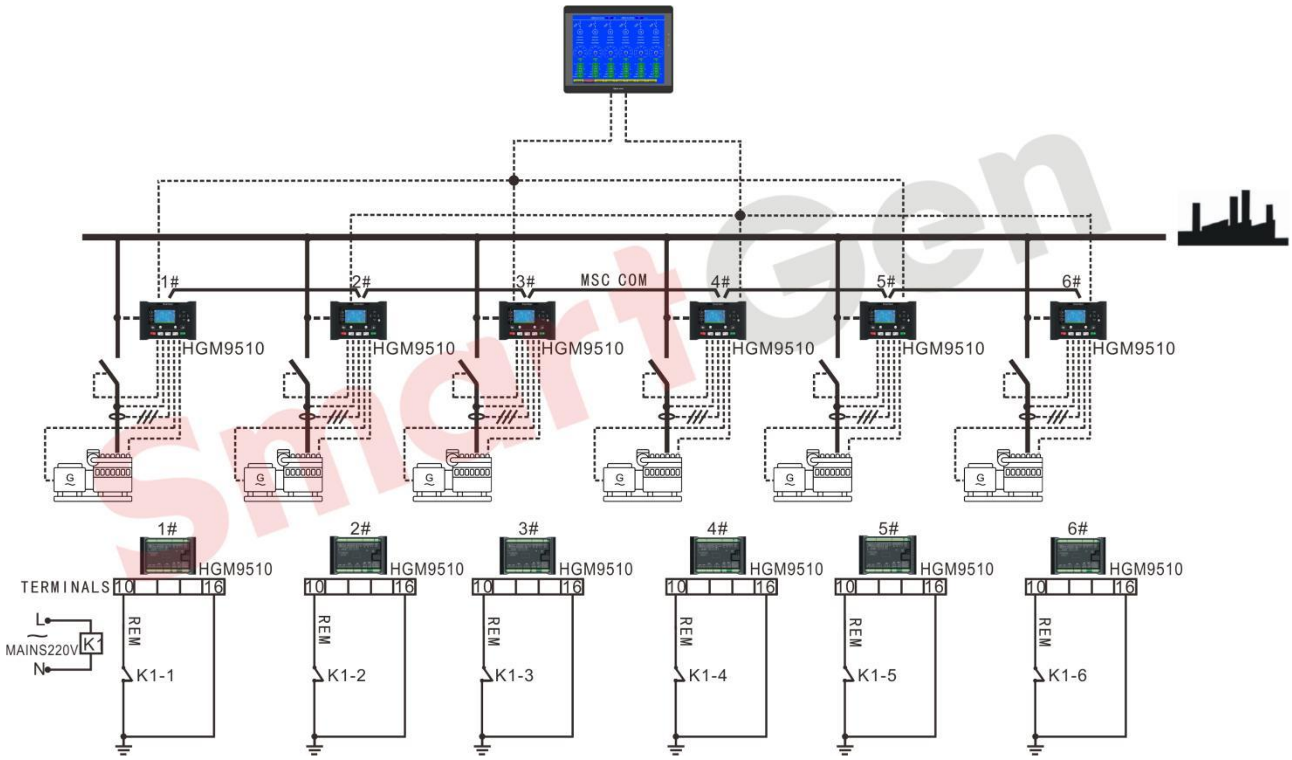


Fig. 26 Application diagram of six gensets of the same power in synchronization + centralized monitoring

Table 26 Parameters settings of six gensets of the same power in synchronization + centralized monitoring

Items	Parameters	Setting Values						Remark
		Gen 1	Gen 2	Gen 3	Gen 4	Gen 5	Gen 6	
HGM9510 Module Settings	Module address	1	2	3	4	5	6	
HGM9510 Engine Settings	Engine type	Refer to<Parameter Setting of EFI Unit>						
	Rated speed	1500r/min						
	Crank disconnect conditions	Frequency + Speed						
HGM9510 Generator Settings	AC system	3P4W						
	Rated voltage	230V						
	Rated frequency	50Hz						

Items	Parameters	Setting Values						Remark
		Gen 1	Gen 2	Gen 3	Gen 4	Gen 5	Gen 6	
	CT primary	1200/5						CT primary selection＞full load rated current
	Full load rating (rated current)	1080A						Full load rated current=rated power×1.8
	Full kW rating (rated kW power)	600kW						
	Full kvar rating (rated kvar power)	450kvar						Setting based on PF 0.8
HGM9510 Digital Inputs Settings	Digital input 1	Remote start(Start Sets as Load Require)						
	Digital input 4	Gen close auxiliary						
HGM9510 Relay Outputs Settings	Relay output 5	Open gen output						
	Relay output 6	Close gen output						
HGM9510 Sync. Settings	MSC number	6						
	Starting option	Start sets as load require						
	Calling for More Sets(%) (the maximum load percentage when to start the genset)	80%						1. Call more sets power = full load kW of current N synchronizing gensets × call more sets (%) 2. call more sets (%)=call more sets power/ full load kW of current N synchronizing gensets. ⚠ **Note: "N" means the number of synchronized gensets.** **In this example, when N=1, the Gen2 will start, when N=2, the Gen3 will start, and when N=3, the Gen4 will start.**

Items	Parameters	Setting Values						Remark
		Gen 1	Gen 2	Gen 3	Gen 4	Gen 5	Gen 6	
	Calling for less sets(the maximum load percentage when to stop the genset)	40%						1. Call less sets power = full load kW of current N synchronizing gensets $\times\frac{(N-1)}{N}\times$call less sets (%) 2.Call less sets (%)=Call less sets power/ full load kW of current N synchronizing gensets $\times\frac{N}{(N-1)}$ **Note: "1" in the formula means the genset with the lowest priority that will be called for stopped; "N" means the number of synchronized gensets.** **In this example, when N=4, the Gen4 will stop, when N=3, the Gen3 will stop, and when N=2, the Gen2 will stop.** **Note: calling for less sets power means the load power.** **Note: if there are many genset running in synchronization, it is recommended to reduce the percentage of calling for less sets to avoid frequent start and shutdown of gensets.**

<table>
<tr><th rowspan="2">Items</th><th rowspan="2">Parameters</th><th colspan="6">Setting Values</th><th>Remark</th></tr>
<tr><th>Gen 1</th><th>Gen 2</th><th>Gen 3</th><th>Gen 4</th><th>Gen 5</th><th>Gen 6</th><th></th></tr>
<tr><td rowspan="3">HGM9510 Sync. Calibration</td><td>(MSC)ID</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td></td></tr>
<tr><td>Module Priority</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td></td></tr>
<tr><td>GOV/AVR</td><td colspan="6">GOV:(SW1:5; SW2:2)
AVR:(SW1:0; SW2:2)</td><td>Refer to <HGM9500 controller GOV/AVR parameter setting></td></tr>
<tr><td rowspan="2">HMU15 System Settings</td><td>MSC number</td><td colspan="6">6</td><td></td></tr>
<tr><td>Genset Power</td><td colspan="6">600kW</td><td>Configured from the front panel ofHMU15</td></tr>
</table>

⚠ Note: HMU15 communicates with HGM9510 via RS485 port, one end of the communication cable is DB9 connects to HMU15, and the other end of the cable has six wires (two groups of RS485 ports). One group of RS485 connects with three units of HGM9510 controller (COM address set as 1, 3, 5), and the other group of RS485 connects with the other three units of HGM9510 controller (COM address set as 2, 4, 6).

After above parameters set completely, when controller is in the auto mode and the remote start input is active, Gen1 will start. If the current load power is greater than the calling for more sets power 480kW, Gen2 will start and synchronize with Gen1 to share the load evenly; If the current load power is greater than the calling for more sets power 960kW, Gen3 will start and synchronize with the Bus and three gensets will share the load evenly; If the current load power is greater than the calling for more sets power 1440kW, Gen4 will start and synchronize with the Bus and four gensets will share the load evenly; If the current load power is greater than the calling for more sets power 1920kW, Gen5 will start and synchronize with the Bus and five gensets will share the load evenly; If the current load power is greater than the calling for more sets power 2400kW, Gen6 will start and synchronize with the Bus and six gensets will share the load evenly;

If the current load power is less than the calling for less sets power 1200kW, Gen6 will unload and stop, and five gensets will share the load evenly; If the current load power is less than the calling for less sets power 960kW, Gen5 will unload and stop, and four gensets will share the load evenly; If the current load power is less than the calling for less sets power 720kW, Gen4 will unload and stop, and three gensets will share the load evenly; If the current load power is less than the calling for less sets power 480kW, Gen3 will unload and stop, and two gensets will share the load evenly; If the current load power is less than the calling for less sets power 240kW, Gen2 will unload and stop, and only one genset takes the load.

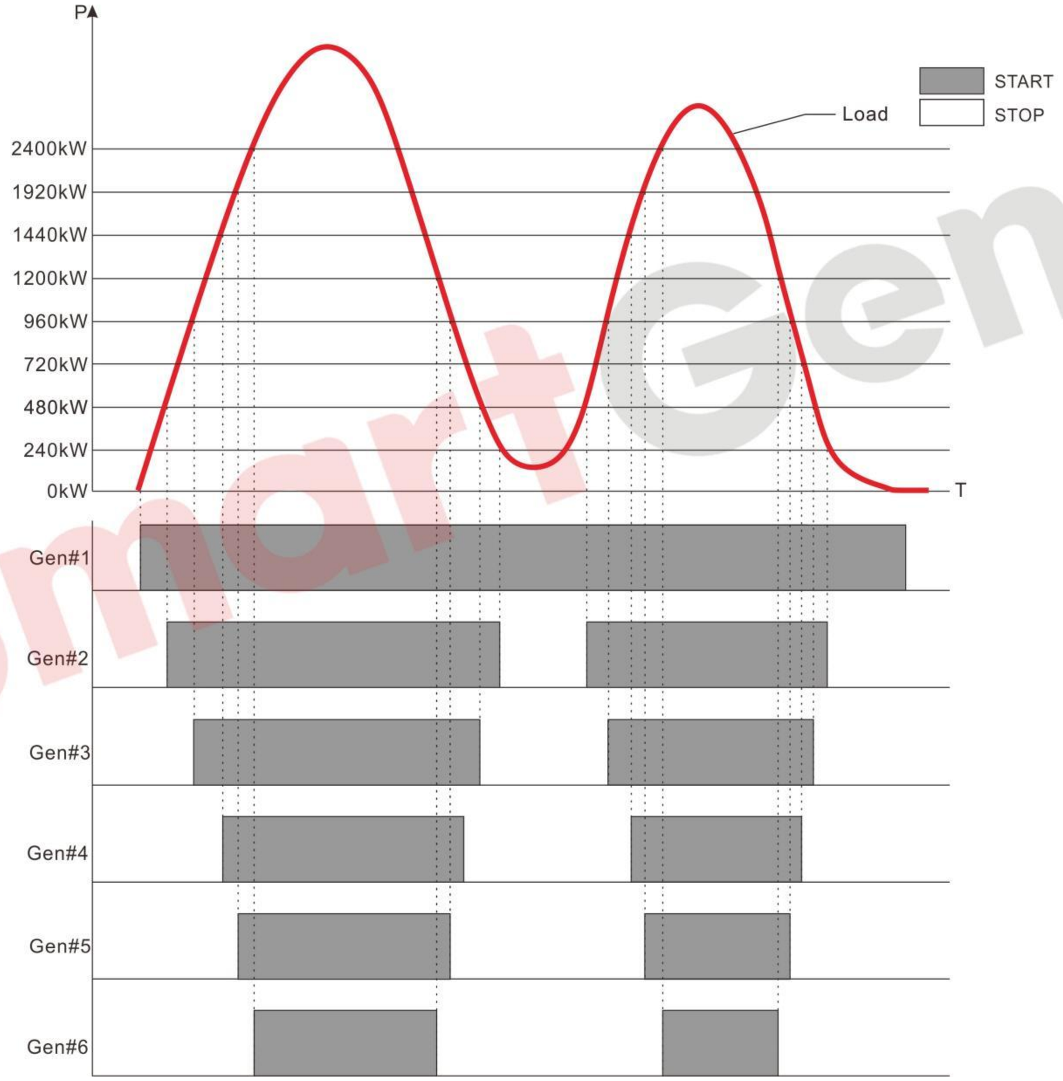


Fig. 27 Synchronized Six gensets start and stop curve

1.6.6 High voltage gensets running in synchronization

This solution is suitable for multiple high-voltage gensets running in synchronization. HGM9510 or HGM9510N controller can be selected to use in applications including factories, power plants, etc.

Example 25: There are four 1000kW high-voltage gensets with rated voltage 10.5kV, and engine voltage regulating board is DVR2000. One genset needs to be started and take the load firstly and the other three gensets will start/stop based on the load requirement.

This application needs to install voltage transformers on the busbar and generator side for controller voltage sampling.

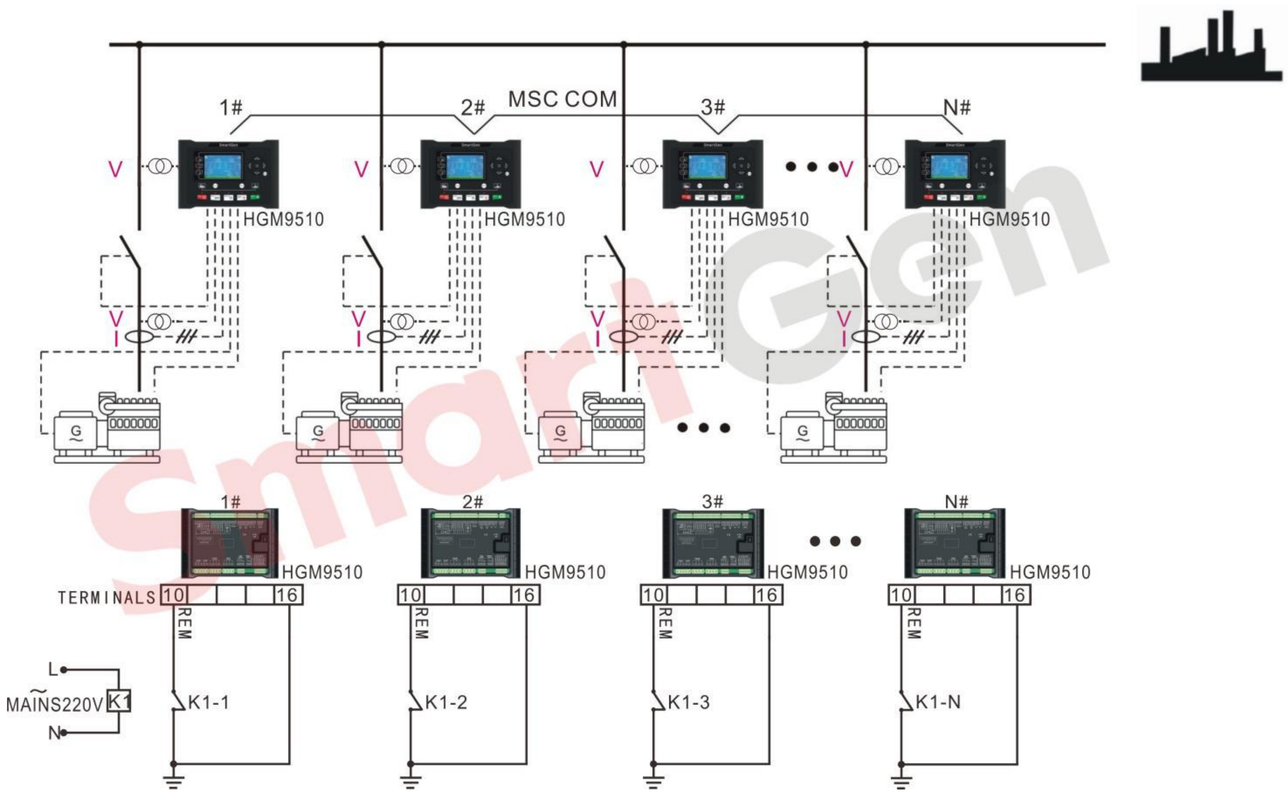


Fig. 28 Application diagram of multiple high-voltage gensets running in synchronizatio

Table 27 Application Related Parameter Configuration of Four High Voltage Gensets with Same Power

Items	Parameters	Set value				Remarks
		Gen 1	Gen 2	Gen 3	Gen 4	
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>				
	Rated Speed	1500r/min				
	Crank Disconnect	Frequency + Engine Speed				
Generator Setting	AC System	3P3W				
	Gen Rated Voltage (Rated Voltage)	10500V				
	Gen Rated Frequency (Rated Frequency)	50Hz				
	Voltage Transformer	Primary: 10500V Secondary: 100V				
	CT	100/5				CT Selection ＞ Full Load Rated Current

	Full Load Rated Current (Rated Current)	69A	$满载额定电流=\left(\frac{额定功率}{额定电压\times\sqrt{3}}\right)\div 0.8$
	Full Load Rated Active Power (Rated Active Power)	1000kW	
	Full Load Rated Reactive Power (Rated Reactive Power)	740kvar	Set according to PF=0.8
Inputs Setting	Digital Input 1	Remote start (on demand).	
	Digital Input 4	Gen close status input	
Outputs Setting	Digital Output 5	Open Gen Output	
	Digital Output 6	Close Gen Output	
Sync Setting	Num. On MSC Bus	4	
	Starting Option	Start Sets as Load Requires	
	Call More sets (%) (Startup Max. load percentage)	80%	1. Schedule power at startup=Full load active power of current N sets in parallel × Schedule startup load percentage 2. Schedule startup load percentage=Schedule power at startup / Full load active power of current N sets in parallel **Note: "N" indicates the number of parallel sets.** **In this case, second set is scheduled to start N=1, third set is scheduled to start N=2, and fourth set is scheduled to start N=3.**
	Call Less sets (%) (Max. load	40%	1. Schedule power at shutdown=Full load active power

	percentage at shutdown)					of current N sets in parallel×$\frac{(N-1)}{N}$×Schedule shutdown load percentage 2. Schedule shutdown load percentage=Schedule power at shutdown / Full load active power of current N sets in parallel×$\frac{N}{(N-1)}$ **Note: "1" in the Formula indicates the set with the lowest priority to shut down in the parallel sets; "N" indicates the number of parallel sets.** **In this case, fourth set is scheduled to shut down N=4, third set is scheduled to shut down N=3, and second set is scheduled to shut down N=2.** **Note: Power refers to load power during scheduling shutdown.** **Note: When there are many parallel sets, it is recommended to reduce the schedule shutdown load percentage to avoid frequent startup and shutdown of sets.**
Sync Calibration	MSC ID	1	2	3	4	
	Module Priority	1	2	3	4	
	GOV/AVR	GOV:(SW1:9; SW2:2) AVR:(SW1:0; SW2:2)				Refer to <HGM9500 controller GOV/AVR parameter setting>

The above parameter setting is completed, the controller is in Auto mode, when the remote start input is valid, set 1 will start with load, if the current load power is greater than the rated power of set 1 by 800kW, set 2 will start in parallel with the bus, and the two sets will share the current load power equally. If the current load power is greater than 1600kW at the time of scheduled start-up, set 3 will start in parallel with the bus, and the three sets share the current load power equally; If the current load power is greater than 2400kW at the time of

scheduled start-up, set 4 will start in parallel with the bus, and the four sets share the current load power equally.

If the current load power is less than 1200kW at the scheduled shutdown, the set 4 will be shut down by soft unloading, and the three units will share the current load power equally; If the current load power is less than 800kW at the scheduled shutdown, the set 3 will be shut down by soft unloading, and the two units will share the current load power equally; If the current load power is less than 400kW at the scheduled shutdown, the set 2 will be shut down by soft unloading and a single unit will be loaded.

1.6.7 High Voltage Parallel (Step-up Transformer)

This solution is suitable for parallel application of multiple low-voltage sets starting on demand. After boosting by transformer, it can supply power to the load. HGM9510 or HGM9510N can be selected. The application occasions include factory, mobile power station, etc.

Example 26: Four EFI sets with rated power of 550kW are in parallel, and the model of the generator AVR is SX440. After the generator is closed, the booster output is boosted to supply power to the load. It is required to start a single set with load first, and start/stop the other three sets according to the load.

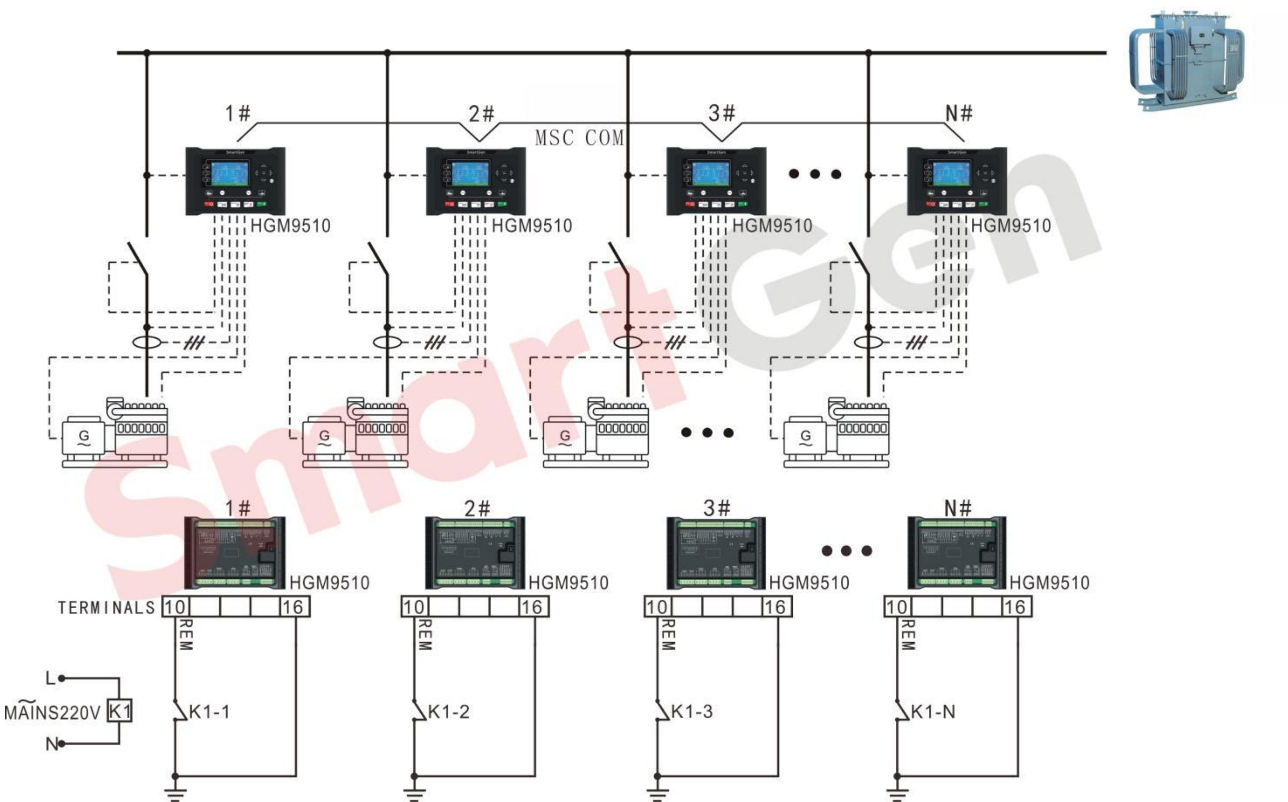


Fig.29 Application Diagram of Multiple High Voltage Parallel (Step-up Transformer) with Same Power

Table 28 Application Related Parameter Configuration of Four High Voltage Gensets Parallel (Step-up Transformer) with Same Power

Items	Parameters	Set value				Remarks
		Gen 1	Gen 2	Gen 3	Gen 4	
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>				
	Rated Speed	1500r/min				
	Crank Disconnect	Frequency + Engine Speed				
Generator Setting	AC System	3P4W				
	Gen Rated Voltage (Rated Voltage)	230V				
	Gen Rated Frequency (Rated Frequency)	50Hz				
	CT	1000/5				CT Selection ＞ Full Load Rated Current
	Full Load Rated Current (Rated Current)	990A				Full Load Rated Current= Rated Power×1.8
	Full Load Rated Active Power (Rated Active Power)	550kW				
	Full Load Rated Reactive Power (Rated Reactive Power)	410kvar				Set according to PF=0.8
Inputs Setting	Digital Input 1	Remote start (on demand).				
	Digital Input 14	Gen close status input				
Outputs Setting	Digital Output 5	Open Gen Output				
	Digital Output 56	Close Gen Output				
Sync Setting	Num. On MSC Bus	4				
	Starting Option	Start Sets as Load Requires				
	Call More sets (%)	80%				1. Schedule power at startup=Full load active power of current N sets in parallel × Schedule startup

Items	Parameters	Set value				Remarks
		Gen 1	Gen 2	Gen 3	Gen 4	
						load percentage 2. Schedule startup load percentage=Schedule power at startup / Full load active power of current N sets in parallel **Note: "N" indicates the number of parallel sets.** **In this case, second set is scheduled to start N=1, third set is scheduled to start N=2, and fourth set is scheduled to start N=3.**
	Call Less sets (%)	40%				1. Schedule power at shutdown=Full load active power of current N sets in parallel×$\frac{(N-1)}{N}$× Schedule shutdown load percentage 2. Schedule shutdown load percentage=Schedule power at shutdown / Full load active power of current N sets in parallel×$\frac{N}{(N-1)}$ **Note: "1" in the Formula indicates the set with the lowest priority to shut down in the parallel sets; "N" indicates the number of parallel sets.** **In this case, fourth set is scheduled to shut down N=4, third set is scheduled to shut down**

Items	Parameters	Set value				Remarks
		Gen 1	Gen 2	Gen 3	Gen 4	
						N=3, and second set is scheduled to shut down N=2. **Note: Power refers to load power during scheduling shutdown.** **When there are many parallel sets, it is recommended to reduce the schedule shutdown load percentage to avoid frequent startup and shutdown of sets.**
Sync Calibration	MSC ID	1	2	3	4	
	Module Priority	1	2	3	4	
	GOV/AVR	GOV:(SW1:5;SW2:2) AVR:(SW1:0;SW2:2)				Refer to <HGM9500 controller GOV/AVR parameter setting>

The above parameter setting is completed, the controller is in Auto mode, when the remote start input is valid, set 1 will start with load, if the current load power is greater than the rated power of set 1 by 440kW, set 2 will start in parallel with the bus, and the two sets will share the current load power equally. If the current load power is greater than 880kW at the time of scheduled start-up, set 3 will start in parallel with the bus, and the three sets share the current load power equally; If the current load power is greater than 1320kW at the time of scheduled start-up, set 4 will start in parallel with the bus, and the four sets share the current load power equally.

If the current load power is less than 660kW at the scheduled shutdown, the set 4 will be unloaded and shut down, and the three sets will share the current load power equally; If the current load power is less than 440kW at the scheduled shutdown, the set 3 will be unloaded and shut down, and the two sets will share the current load power equally; If the current load power is less than 220kW at the scheduled shutdown, the set 2 will be unloaded and shut down and a single set will be loaded.

1.6.8 Redundant Parallel

This solution is suitable for parallel application of multiple sets starting on demand, and has the function of redundant backup. HGM9530N should be selected. The application occasions include Data center, Bank, etc.

The controller redundancy system consists of two controllers. The two controllers shall be set with the same ID, and the redundant controller should enable the redundant controller in the module setting.

When the redundant controller detects the failure of the main controller (the redundant controller does not receive the data frame sent by the main controller in MSC communication, or the redundant controller receives a valid output signal of the redundant controller sent by the main controller), the redundant controller takes over the control of the set, outputs the effective signal of the redundant controller to the main controller and switches the control signal at the same time.

1.6.9 GOV/AVR Two Control Methods

Method 1: Use electronic potentiometer HEP300.The main controller and the redundant controller output the digital signal to the UP/DOWN input of HEP300, and the analog output of HEP300 is connected to the GOV (AVR). In this way, when the main controller is switched with the redundant controller, the voltage signal output to the GOV (AVR) will not be interrupted, and the set will be smoothly transitioned to the redundant controller.

Method 2: The relay is used to directly switch the GOV and AVR control outputs of both controllers. The circuit of this method is simple, but when the main controller is switched with the redundant controller, the voltage signal output to the governor will be interrupted, which may lead to the fluctuation of some units.

Example 27: Two EFI sets with rated power of 1500kW are in parallel, and the rated voltage is 10.5kv. The model of generator AVR is DVR2000. In addition to normal parallel function, the parallel system shall have redundant function. It is required to start a single set with load first, and start/stop the other set according to the load.

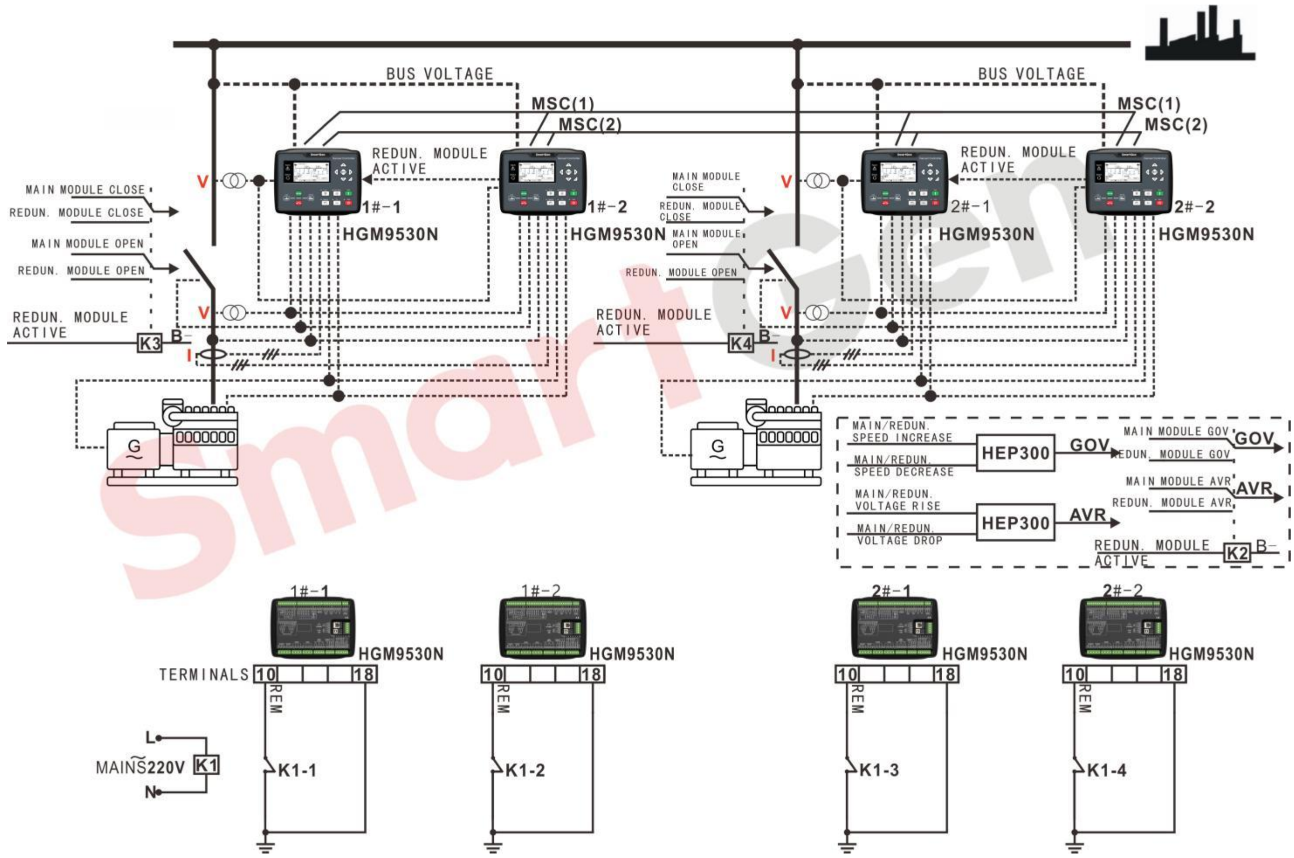


Fig.30 Application Diagram of Two Redundant Parallel Sets

Table 29 Application Related Parameter Configuration of Two Redundant Parallel Sets

Items	Parameters	Set value		Remarks
		Gen 1	Gen 2	
Module Setting	Main/Redundant	Main	Main	
		Redundant	Redundant	
	MSC2	MSC2 Enable		
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>		
	Rated Speed	1500r/min		
	Crank Disconnect	Frequency + Engine Speed		
Generator Setting	AC System	3P3W		
	Rated Voltage	10500V		
	Rated Frequency	50Hz		
	Voltage Transformer	Primary: 10500V Secondary: 100V		
	CT	150/5		CT Selection ＞ Full Load Rated

<table>
<tr><th rowspan="2">Items</th><th rowspan="2">Parameters</th><th colspan="2">Set value</th><th rowspan="2">Remarks</th></tr>
<tr><th>Gen 1</th><th>Gen 2</th></tr>
<tr><td rowspan="4"></td><td></td><td colspan="2"></td><td>Current</td></tr>
<tr><td>Full Load Rated Current</td><td colspan="2">103A</td><td>$满载额定电流=\left(\frac{额定功率}{额定电压\times\sqrt{3}}\right)\div 0.8$</td></tr>
<tr><td>Full Load Rated Active Power</td><td colspan="2">1500kW</td><td></td></tr>
<tr><td>Full Load Reactive Power</td><td colspan="2">1140kvar</td><td>Set according to PF=0.8</td></tr>
<tr><td rowspan="3">Inputs Setting</td><td>Digital Input 1</td><td colspan="2">Remote start (on demand).</td><td></td></tr>
<tr><td>Digital Input 4</td><td colspan="2">Gen close status input</td><td></td></tr>
<tr><td>Digital Input 5</td><td colspan="2">Redundant controller valid</td><td></td></tr>
<tr><td rowspan="7">Outputs Setting</td><td>Digital Output 2</td><td colspan="2">PWM Speed Raise</td><td>No need to set this parameter by using analog speed regulation</td></tr>
<tr><td>Digital Output 3</td><td colspan="2">PWM Speed Drop</td><td>No need to set this parameter by using analog speed regulation</td></tr>
<tr><td>Digital Output 4</td><td colspan="2">Redundant controller valid</td><td></td></tr>
<tr><td>Digital Output 5</td><td colspan="2">Open Gen Output</td><td></td></tr>
<tr><td>Digital Output 6</td><td colspan="2">Close Gen Output</td><td></td></tr>
<tr><td>Digital Output 7</td><td colspan="2">PWM Voltage Raise</td><td>No need to set this parameter by using analog voltage regulation</td></tr>
<tr><td>Digital Output 8</td><td colspan="2">PWM Voltage Drop</td><td>No need to set this parameter by using analog voltage regulation</td></tr>
<tr><td rowspan="3">Sync Setting</td><td>Num. on MSC Bus</td><td colspan="2">2</td><td></td></tr>
<tr><td>Starting Option</td><td colspan="2">Start Sets as Load Requires</td><td></td></tr>
<tr><td>Call More Sets(%)</td><td colspan="2">80%</td><td>1. Schedule power at startup=Full load active power of current N sets in parallel × Schedule startup load percentage
2. Schedule startup load percentage=Schedule power at startup / Full load active power of current N sets in parallel.</td></tr>
</table>

<table>
<tr><th rowspan="2">Items</th><th rowspan="2">Parameters</th><th colspan="2">Set value</th><th rowspan="2">Remarks</th></tr>
<tr><th>Gen 1</th><th>Gen 2</th></tr>
<tr><td rowspan="2"></td><td></td><td colspan="2"></td><td>Note: "N" indicates the number of parallel sets.
In this case, N=1.</td></tr>
<tr><td>Call Less Sets(%)</td><td colspan="2">40%</td><td>1. Schedule power at shutdown=Full load active power of current N sets in parallel×$\frac{(N-1)}{N}$× Schedule shutdown load percentage
2. Schedule shutdown load percentage=Schedule power at shutdown / Full load active power of current N sets in parallel×$\frac{N}{(N-1)}$
Note: "1" in the Formula indicates the set with the lowest priority to shut down in the parallel sets; "N" indicates the number of parallel sets.in this case, N=2.
Note: Power refers to load power during scheduled shutdown.</td></tr>
<tr><td rowspan="7">Sync Calibration</td><td>MSC ID</td><td>1</td><td>2</td><td></td></tr>
<tr><td>Module Priority</td><td>1</td><td>2</td><td></td></tr>
<tr><td>Export Mode(W)</td><td colspan="2">Fixed Power</td><td></td></tr>
<tr><td>Analogue Adjust(W)</td><td colspan="2">Enable</td><td></td></tr>
<tr><td>Export Mode(var)</td><td colspan="2">Fixed Power</td><td></td></tr>
<tr><td>Analogue Adjust(var)</td><td colspan="2">Enable</td><td></td></tr>
<tr><td>GOV/AVR</td><td colspan="2">GOV:(SW1:5;SW2:2)
AVR:(SW1:0;SW2:2)</td><td>Refer to <HGM9500N controller GOV/AVR parameter setting></td></tr>
</table>

The above parameter setting is completed, the main control and redundant controller of the two sets are in Auto mode. When the remote start input is valid, set 1 will start with load, if the current load power is greater than 1200kW at the time of scheduled start-up, set 2 will start in parallel with set 1, and the two sets share the current load power equally. If the current load power is less than 600kW at the scheduled shutdown, set 2 will be unloaded and shut down, and set 1 will be loaded.

During this period, when any redundant controller of the two sets detects that the corresponding main controller is faulty (the redundant controller does not receive the data frame sent by the main controller in the MSC communication, or the redundant controller receives the effective output signal of the redundant controller sent by the main controller), the redundant controller takes over the control of the set, and outputs the effective signal of the redundant controller to the main controller and switches the control signal at the same time.

1.6.10 CCHP (Combined Cooling, Heating and Power)

This solution is suitable for parallel application of multiple generator sets starting on demand, and provides cold and heat supplies at the same time. HGM9530 or HGM9510N can be selected, and the applications are: hotels, field sites, etc.

Example 28: Two gas-fired EFI sets with a rated power of 800kW, and the model of generator AVR is SX440. As a construction site without mains power, the two sets undertake all the power supply tasks. In addition to the parallel power supply function, they also provide heat and cold.

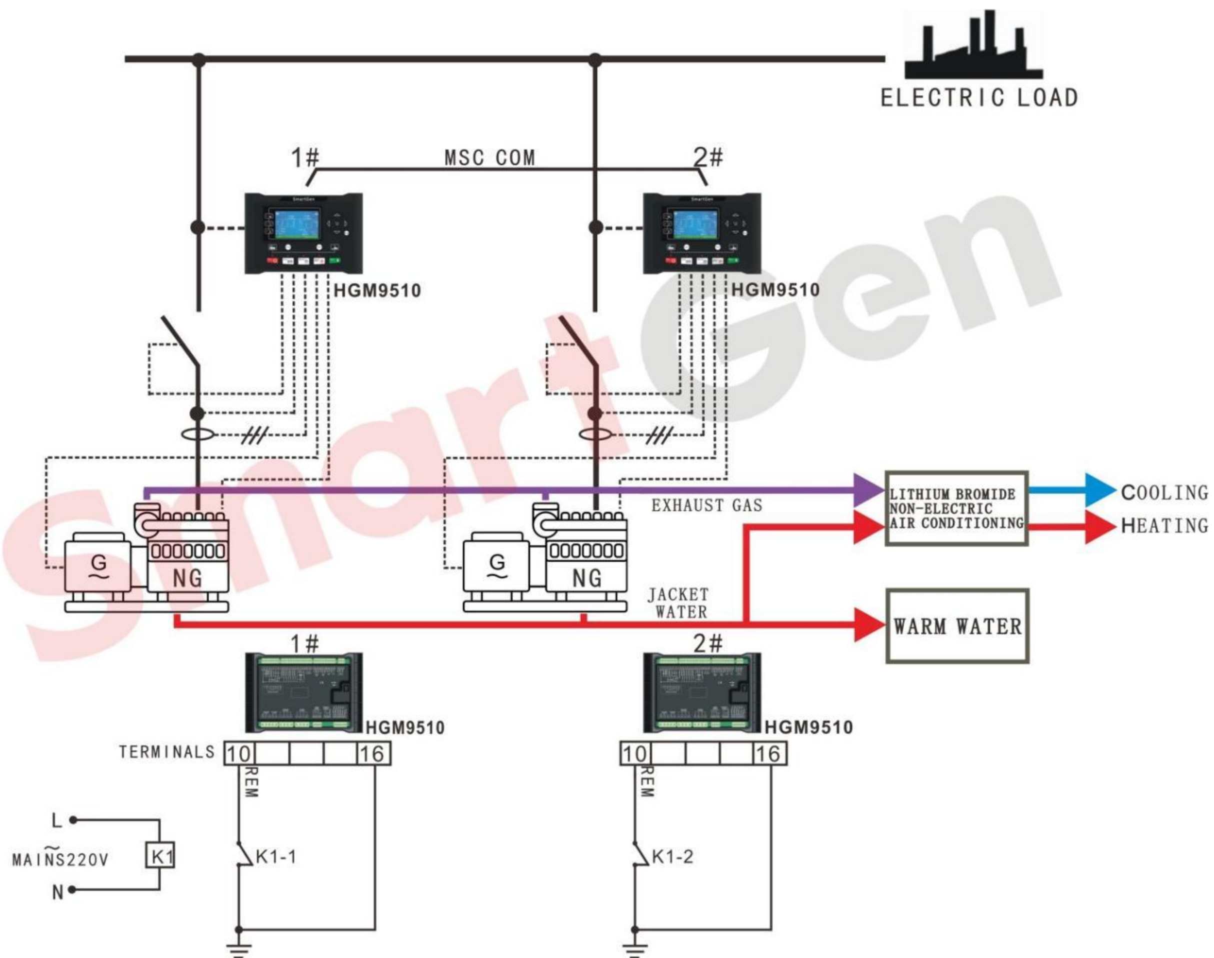


Fig. 31 CCHP Application Diagram of Two Sets with Same Power

Table 30 CCHP Application Related Parameter Configuration of Two Sets with Same Power

Items	Parameters	Set value		Remarks
		Gen 1	Gen 2	
Engine Setting	Engine Type	Refer to<Parameter Setting of EFI Unit>		
	Rated Speed	1500r/min		
	Crank Disconnect	Frequency + Engine Speed		
Generator Setting	AC System	3P4W		
	Gen Rated Voltage (Rated Voltage)	230V		
	Gen Rated Frequency (Rated Frequency)	50Hz		
	CT	3000/5		CT Selection ＞ Full Load Rated Current
	Full Load Rated Current (Rated Current)	1440A		Full Load Rated Current= Rated Power×1.8
	Full Load Rated Active Power (Rated Active Power)	800kW		
	Full Load Rated Reactive Power (Rated Reactive Power)	600kvar		Set according to PF=0.8
Inputs Setting	Digital Input 1	Remote start (on demand).		
	Digital Input 14	Gen close status input		
Outputs Setting	Digital Output 5	Open Gen Output		
	Digital Output 6	Close Gen Output		
Sync Calibration	MSC ID	2		
	Starting Option	Start Sets as Load Requires		

Items	Parameters	Set value		Remarks
		Gen 1	Gen 2	
	Call More sets (%)	80%		1. Schedule power at startup=Full load active power of current N sets in parallel × Schedule startup load percentage 2. Schedule startup load percentage=Schedule power at startup / Full load active power of current N sets in parallel **Note: "N" indicates the number of parallel sets.** **In this case, N=1.**
	Call Less sets (%)	40%		1. Schedule power at shutdown=Full load active power of current N sets in parallel×$\frac{(N-1)}{N}$×Schedule shutdown load percentage 2. Schedule shutdown load percentage=Schedule power at shutdown / Full load active power of current N sets in parallel×$\frac{N}{N-1}$ **Note: "1" in the Formula indicates the set with the lowest priority to shut down in the parallel sets; "N" indicates the number of parallel sets.** **In this case, N=2.** **Note: Power refers to load power during scheduling shutdown**
Sync Calibration	MSC ID	1	2	
	Module Priority	1	2	
	GOV/AVR	GOV:(SW1:5;SW2:2) AVR:(SW1:0;SW2:2)		Refer to <HGM9500 controller GOV/AVR parameter setting>

The above parameter setting is completed, the controller is in Auto mode, when the remote start input is valid, set 1 will start with load. If the current load power is greater than 640kW at the time of scheduled start-up, set 2 will start in parallel with set 1, and the two sets will share the current load power equally.

If the current load power is less than 320kW at the scheduled shutdown, the set 2 will be unloaded and shut down, and set 1 will be loaded.

The working principle of CCHP is:

——The power generated by the generator set supplies power to the load.

——By using natural gas, city gas, waste heat from power generation, industrial waste heat, solar energy, biogas and any heat energy that can generate above 80°C is used as power, and lithium bromide is used as refrigerant for heat exchange, to reduce the temperature of air-conditioning circulating water and achieve the purpose of refrigeration.

——When heating, the cylinder liner water can be directly used for circulating heating, and the high exhaust temperature can be dissipated through the water circulation to increase the temperature of the circulating water of the air conditioner, and also realize the heating of the air conditioner.

The set works for a long time, and the cylinder liner water and the water in the cooling water tank circulate to raise the water temperature in the water tank, so as to provide hot water supply other than drinking, which can be used for bathing, washing clothes and other purposes.

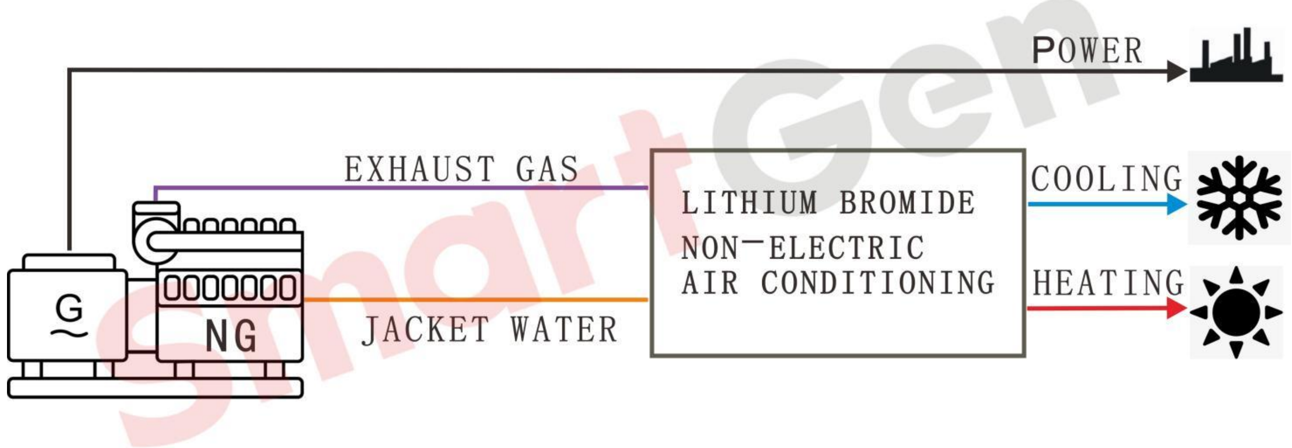


Fig. 32 Structural Application Diagram of CCHP

2 Parameters setting

2.1 Engine Setting

Engine Type /Flywheel Teeth /Rated Speed/Crank Disconnect.

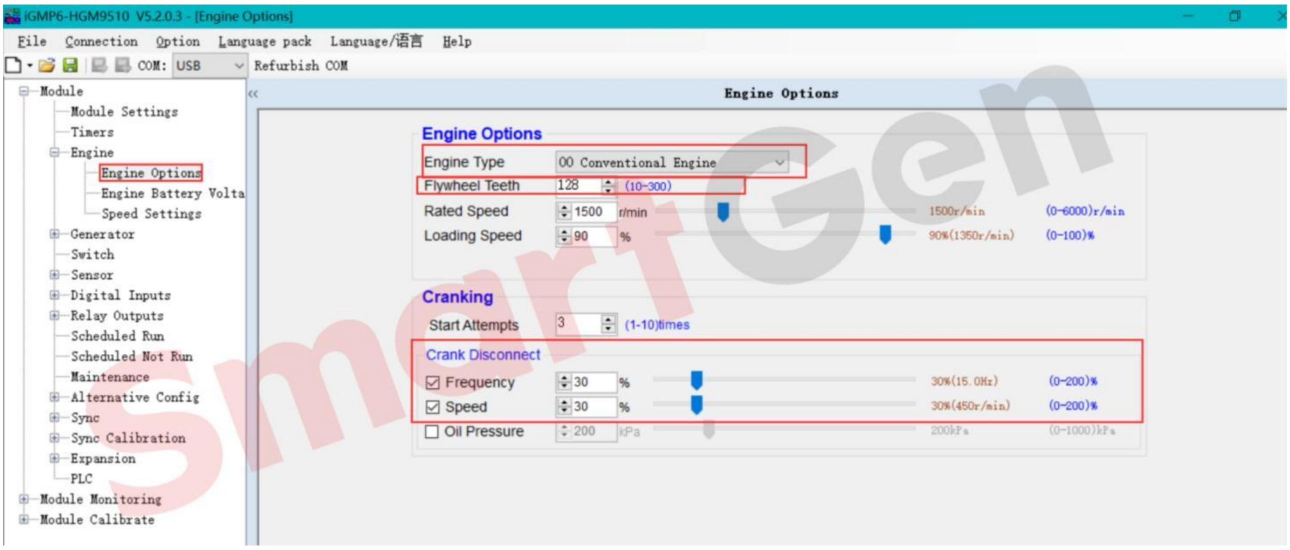


Fig. 33 Engine Options Setting

2.2 Generator Setting

2.2.1 AC System /Rated Voltage/Rated Frequency Setting

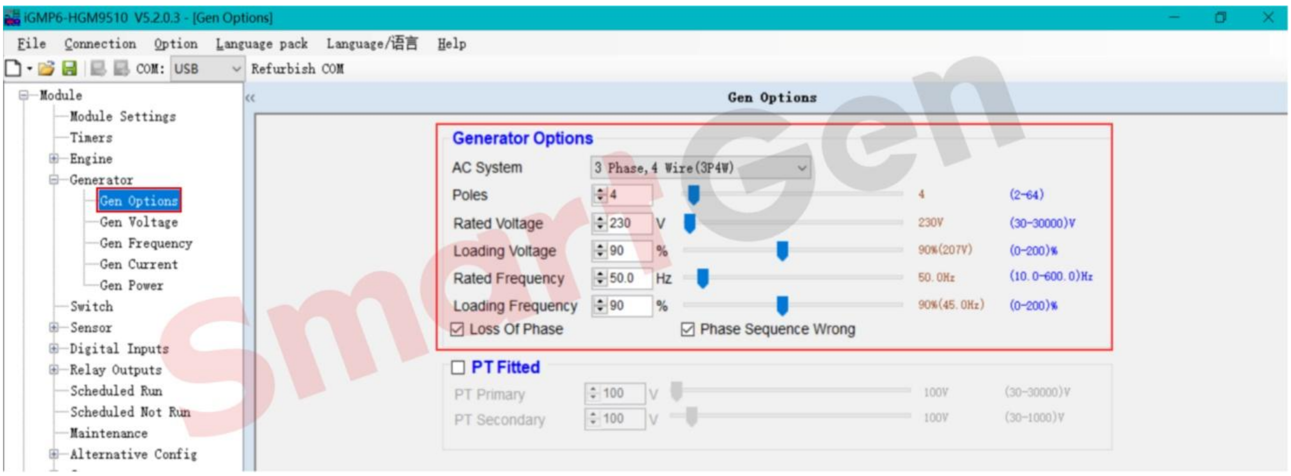


Fig. 34 Generator Options Setting

2.2.2 CT/Full Load Rated Current Setting

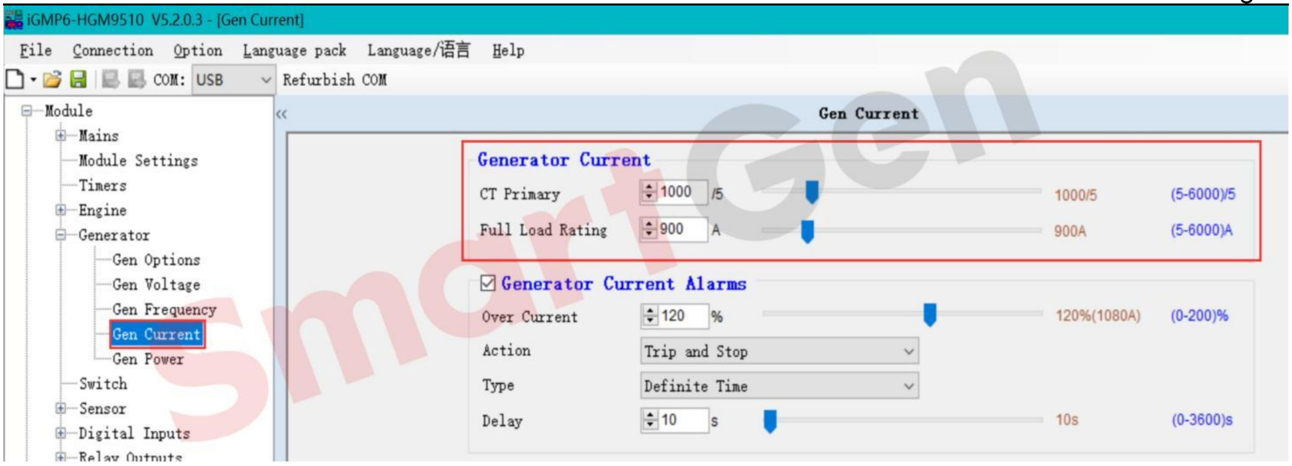


Fig. 35 Generator Current Setting

2.2.3 Full Load Rated Active Power/Full Load Rated Reactive Power Setting

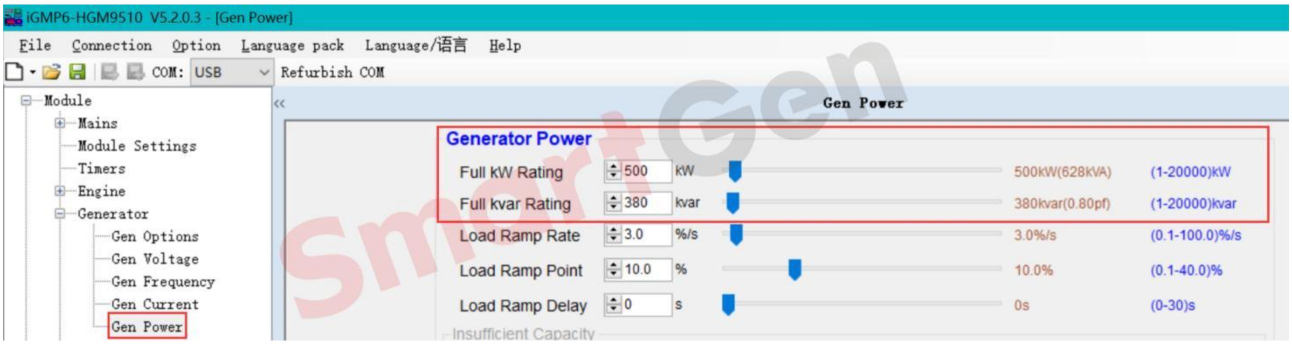


Fig. 36 Generator Power Setting

2.3 Mains Setting

2.3.1 Mains Supply System

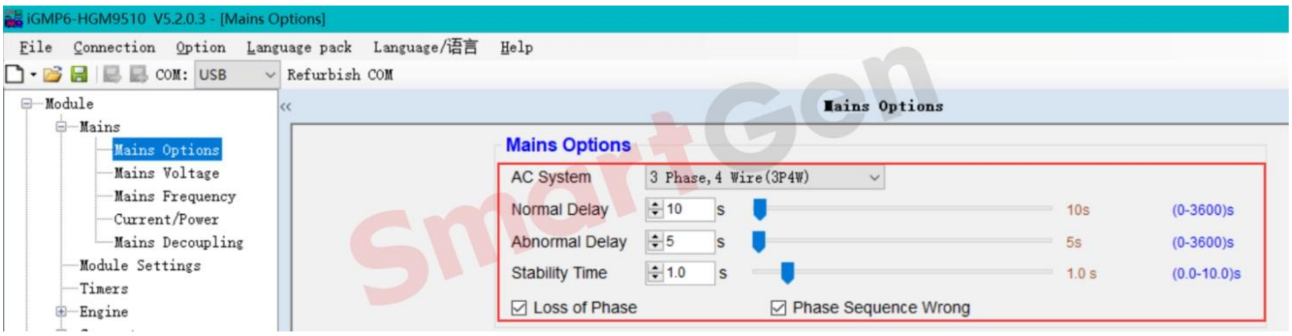


Fig. 37 Mains Options Setting

2.3.2 Mains Rated Voltage

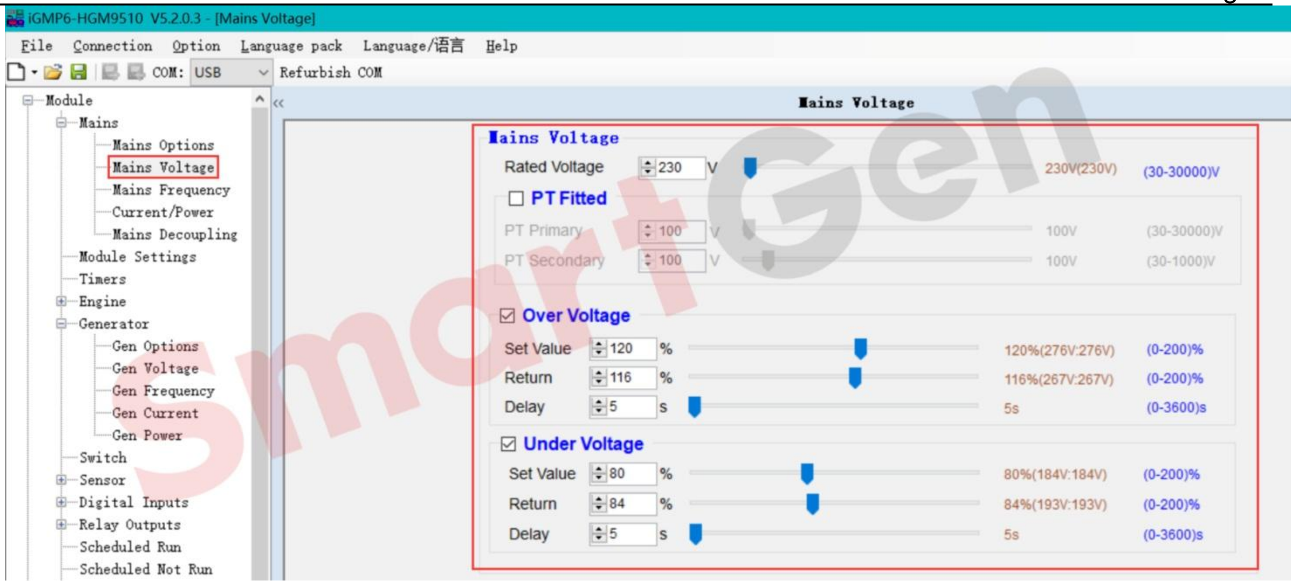


Fig. 38 Mains Voltage Setting

2.3.3 Mains Rated Frequency

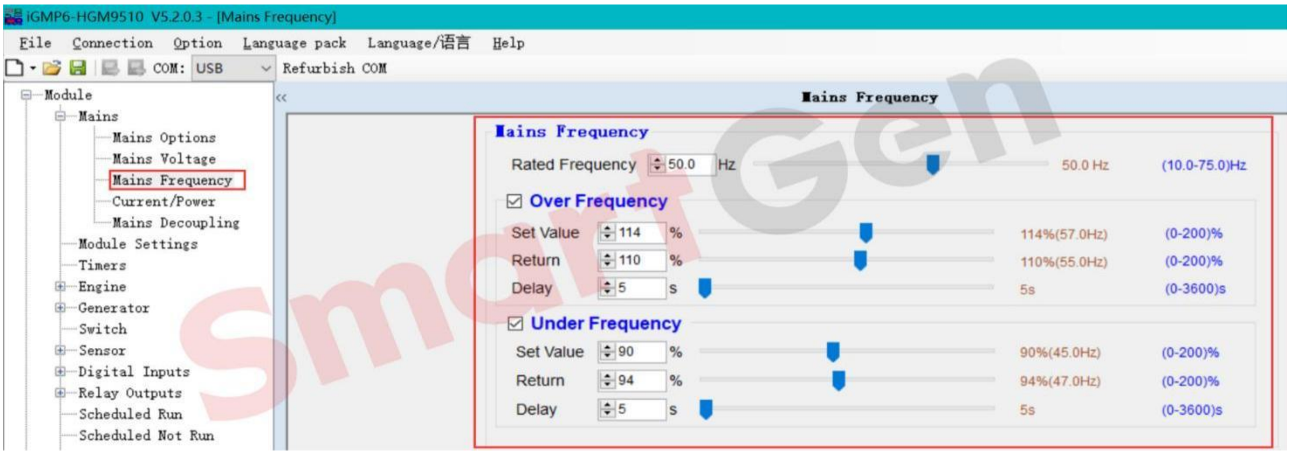


Fig. 39 Mains Frequency Setting

2.3.4 Mains CT/Full Load Active Power/Full Load Reactive Power

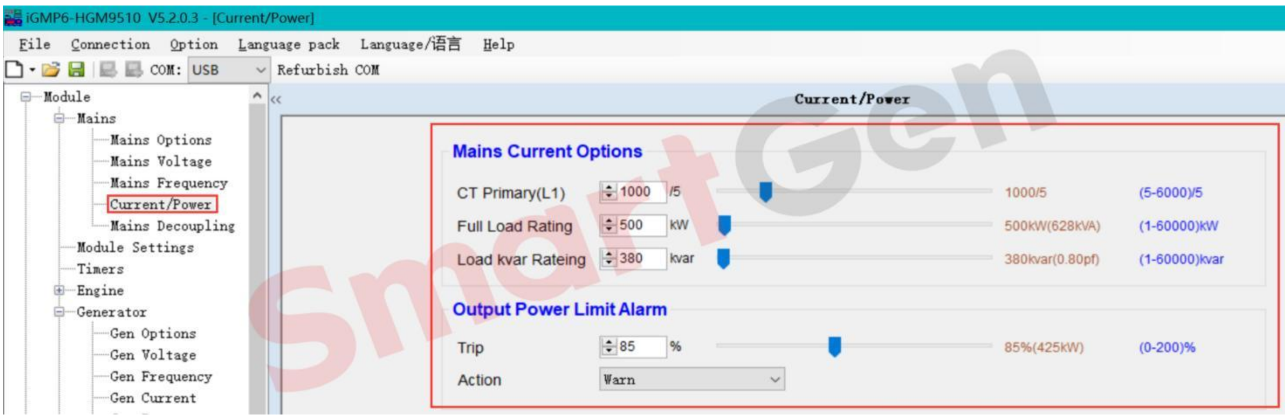


Fig. 40 Current/Power Setting

2.3.5 Mains Decoupling

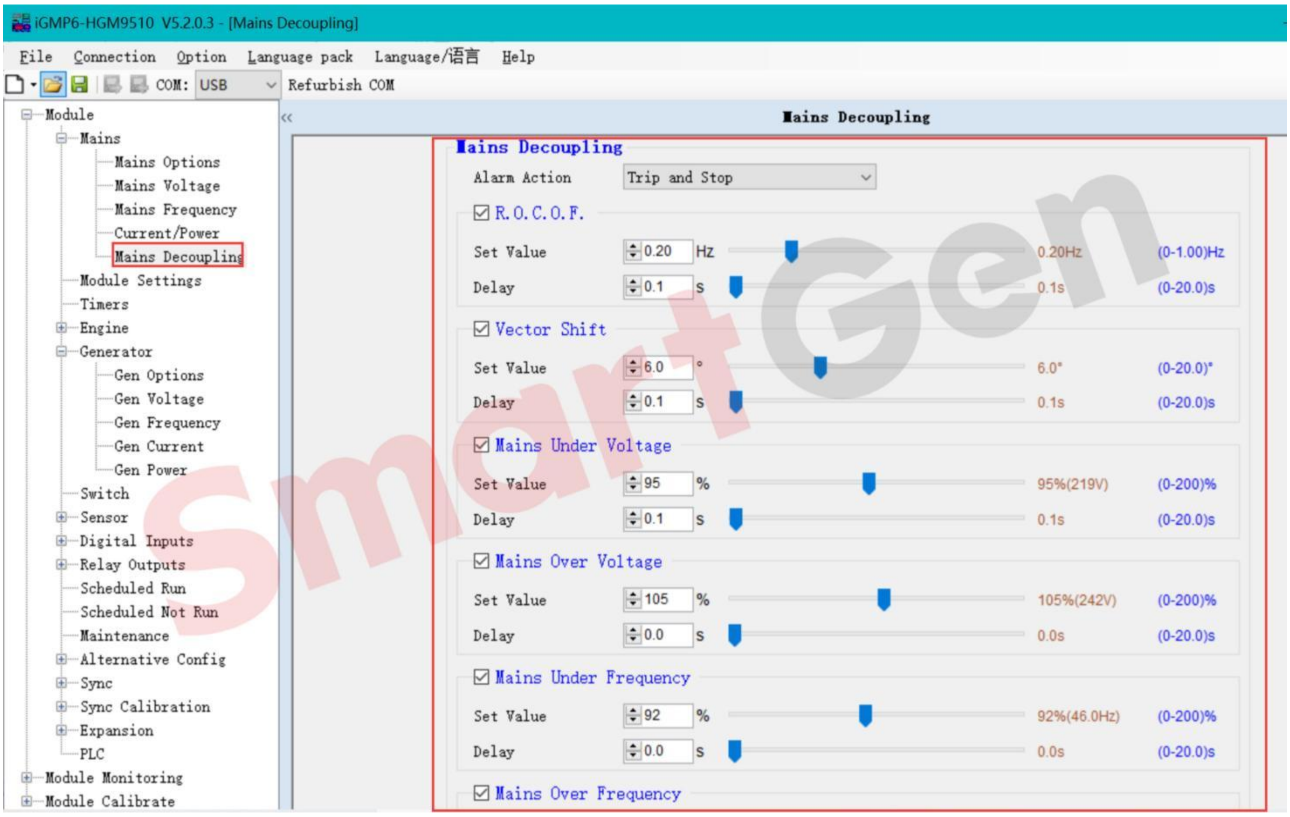


Fig. 41 Mains Decoupling Setting

2.4 Inputs Setting

2.4.1 HGM9510 Gens Parallel Mode Application Digital Inputs Setting

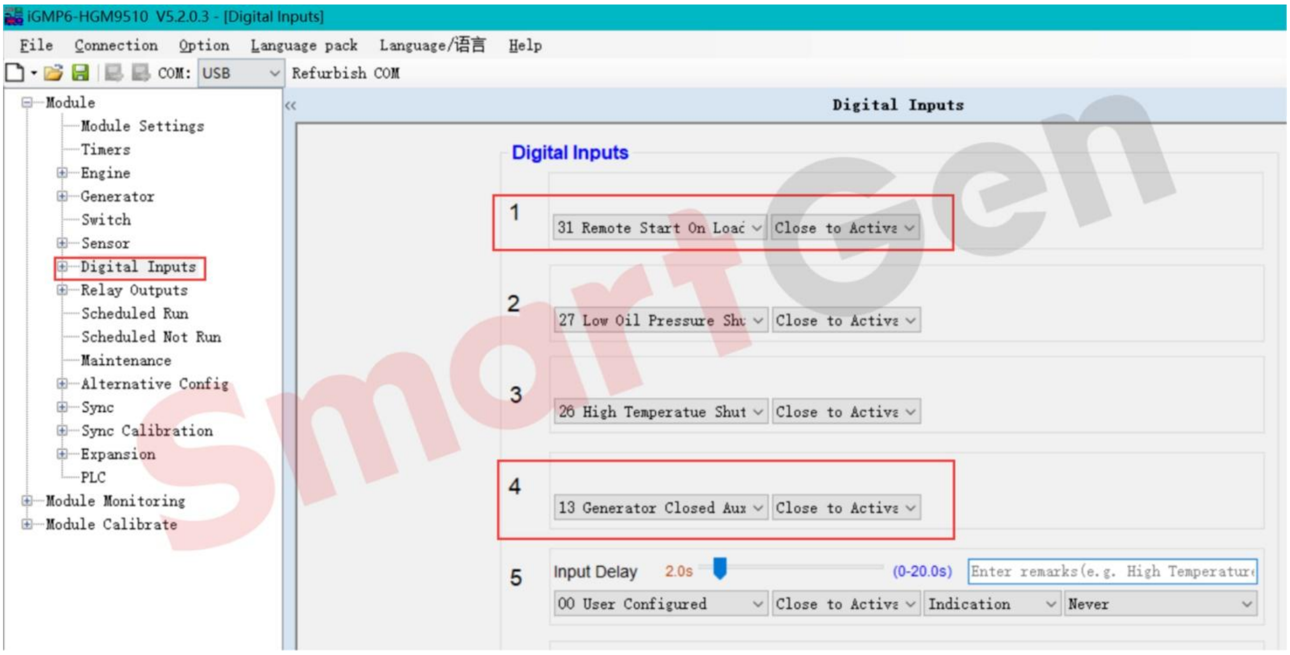


Fig. 42 HGM9510 Gens Parallel Mode Digital Inputs Setting

2.4.2 HGM9510 Mains Parallel Mode Application Digital Inputs Setting

Fig. 43 HGM9510 Mains Parallel Mode Digital Inputs Setting

2.4.3 HGM9510 Power Management Mode Application Digital Inputs Setting

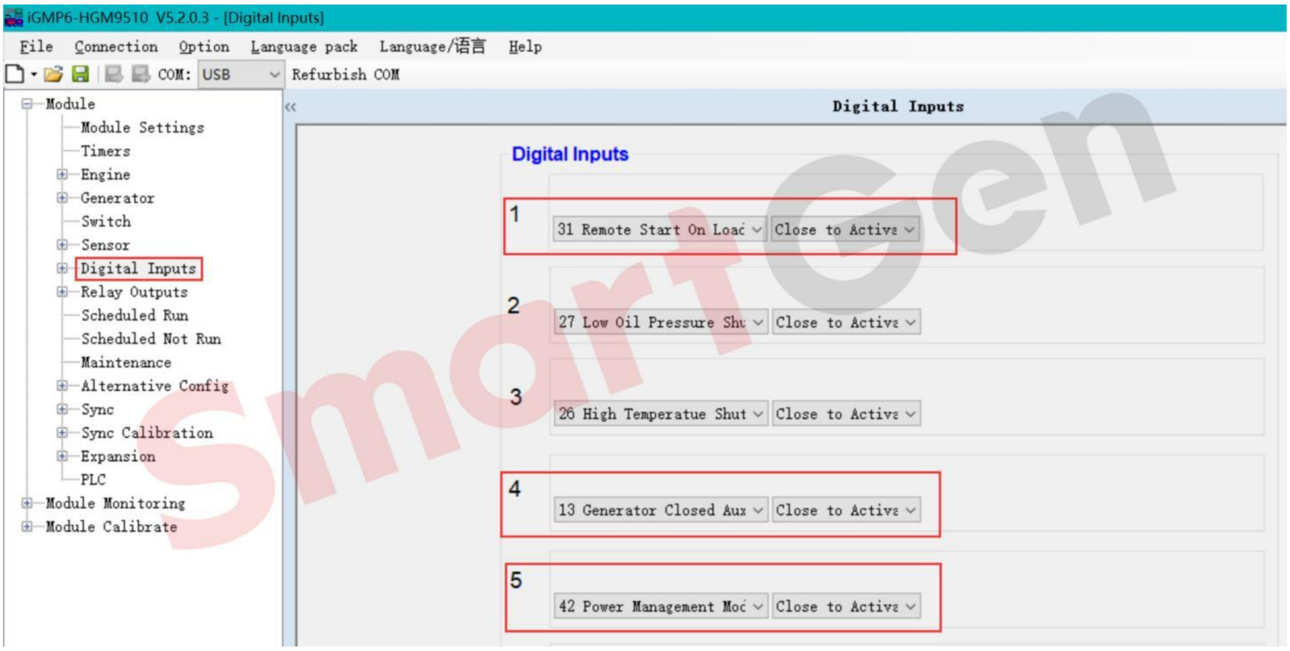


Fig. 44 HGM9510 Power Management Mode Digital Inputs Setting

2.4.4 HGM9520 Single Genset Parallel with Mains /Load Control/AMF Control Mode Application Digital Inputs Setting

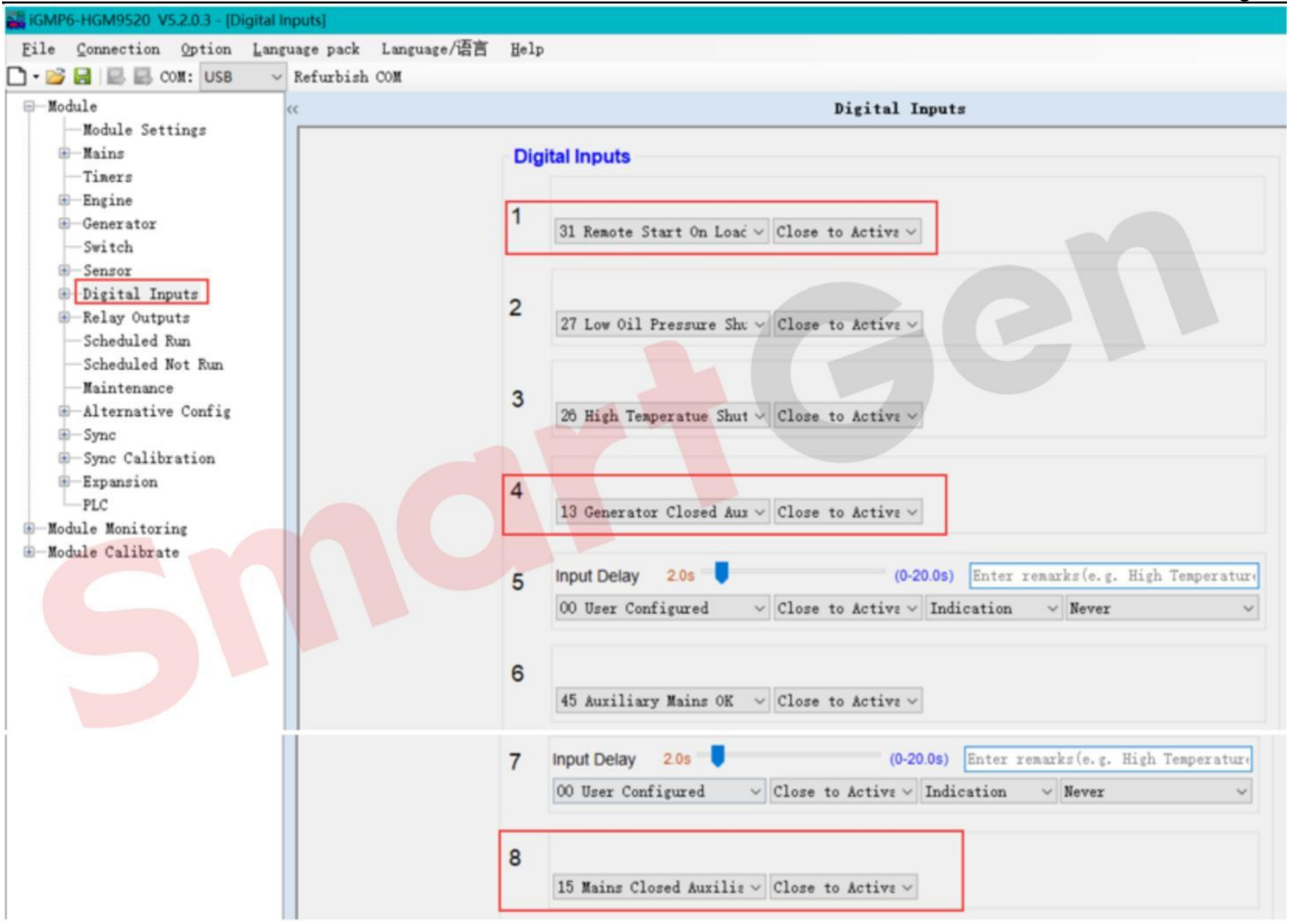


Fig. 45 HGM9520 Digital Inputs Setting

2.4.5 HGM9510N Fast Parallel Mode Application Digital Inputs Setting

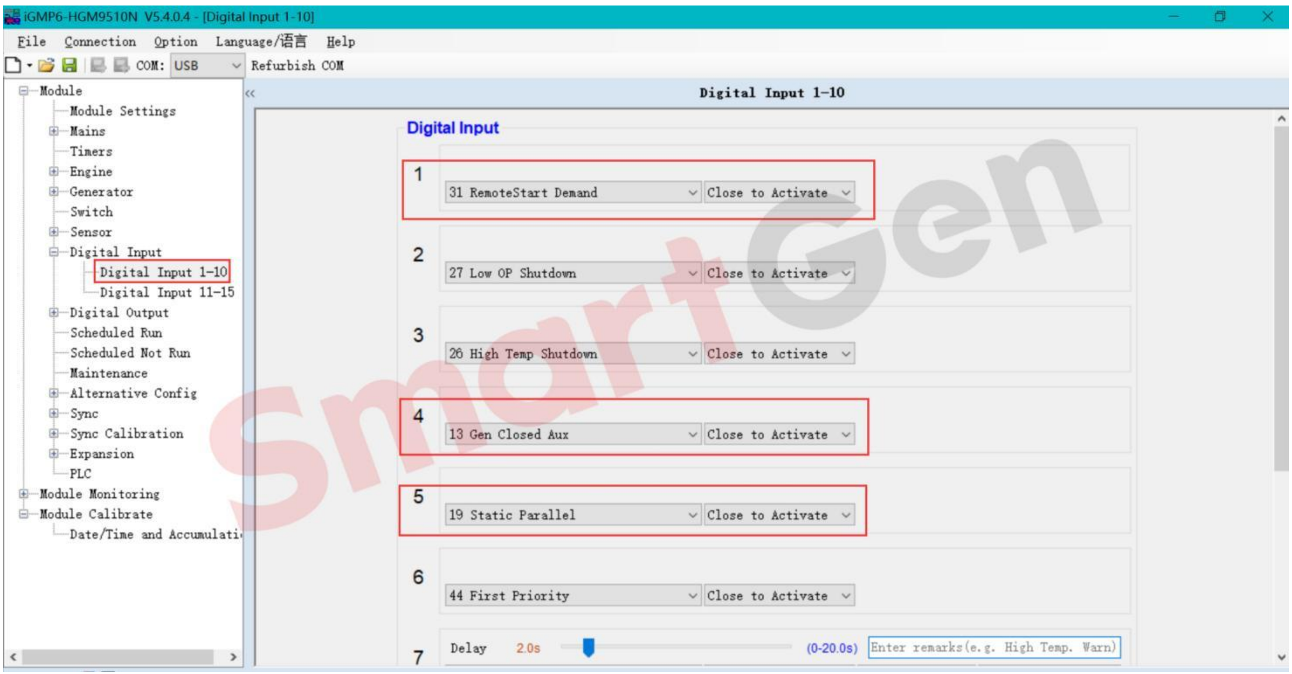


Fig. 46 HGM9510N Fast Parallel Mode Digital Inputs Setting

2.4.6 HGM9510N Black-start Mode Application Digital Inputs Setting

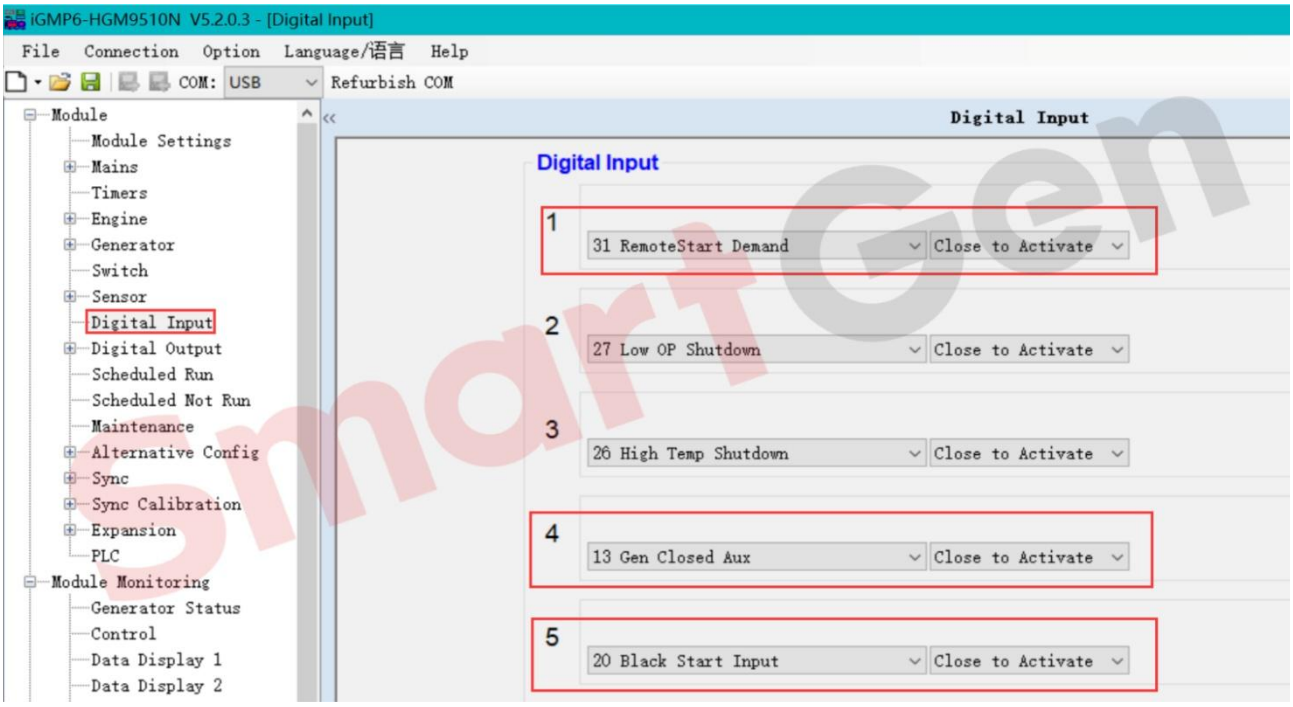


Fig. 47 HGM9510N Black-start Mode Digital Inputs Setting

2.4.7 HGM9560 Busbar Parallel with Mains Application Digital Inputs Setting

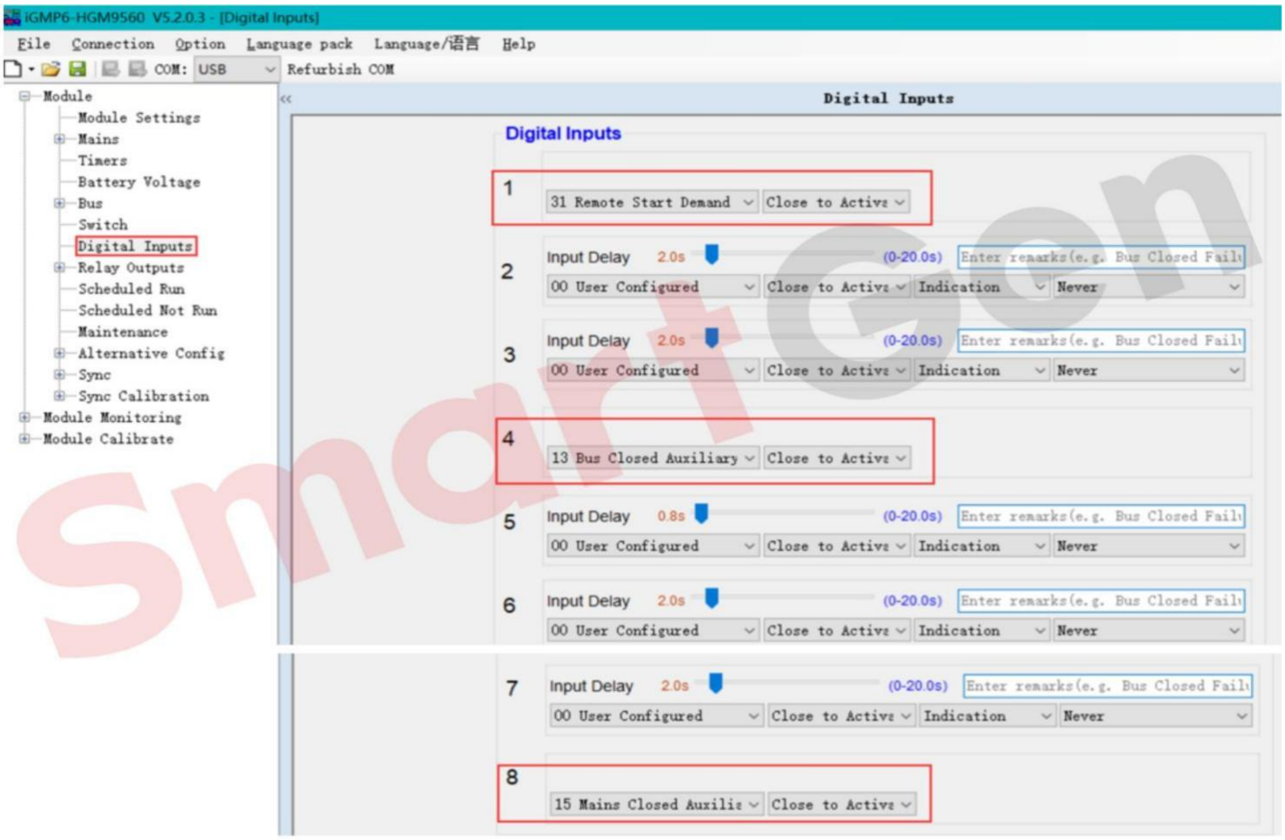


Fig. 48 HGM9560 Busbar Parallel with Mains Digital Inputs Setting

2.4.8 HGM9580 Busbar Parallel Application Digital Inputs Setting

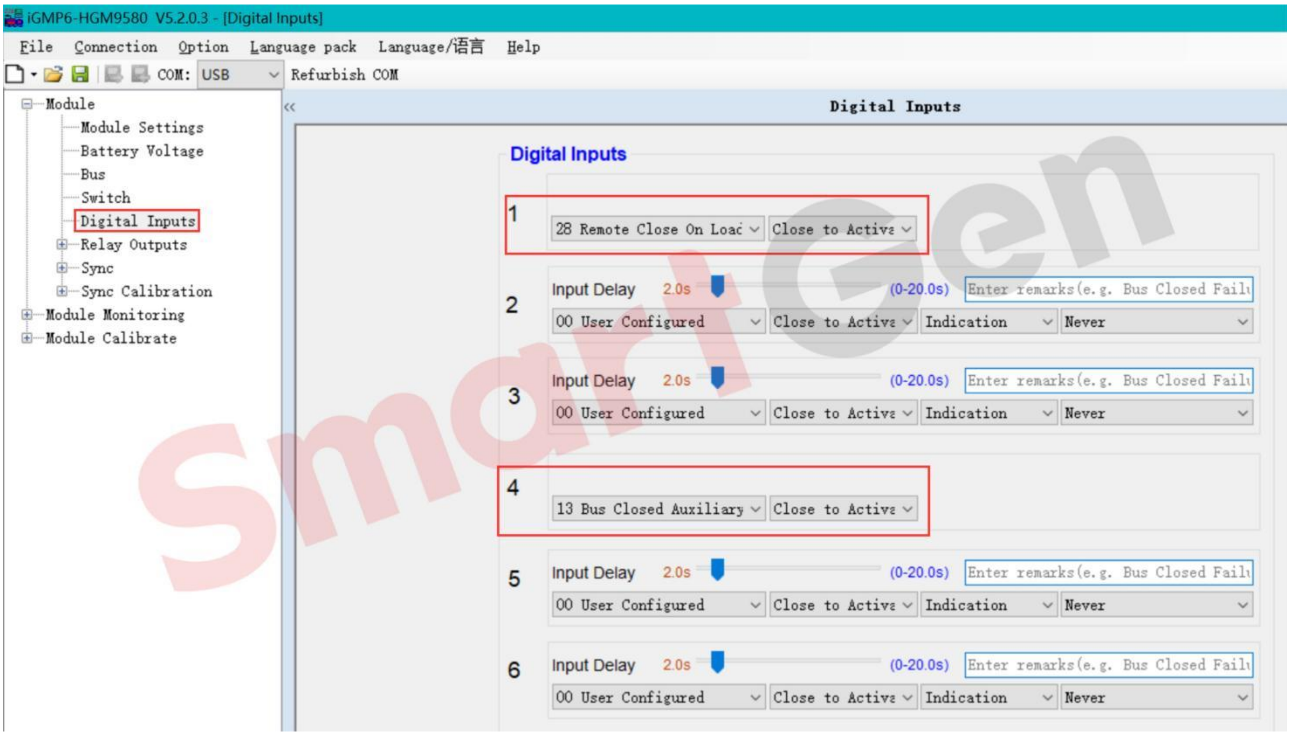


Fig. 49 HGM9580 Busbar Parallel Digital Inputs Setting

2.4.9 HGM9530N Redundancy Mode Application Digital Inputs Setting

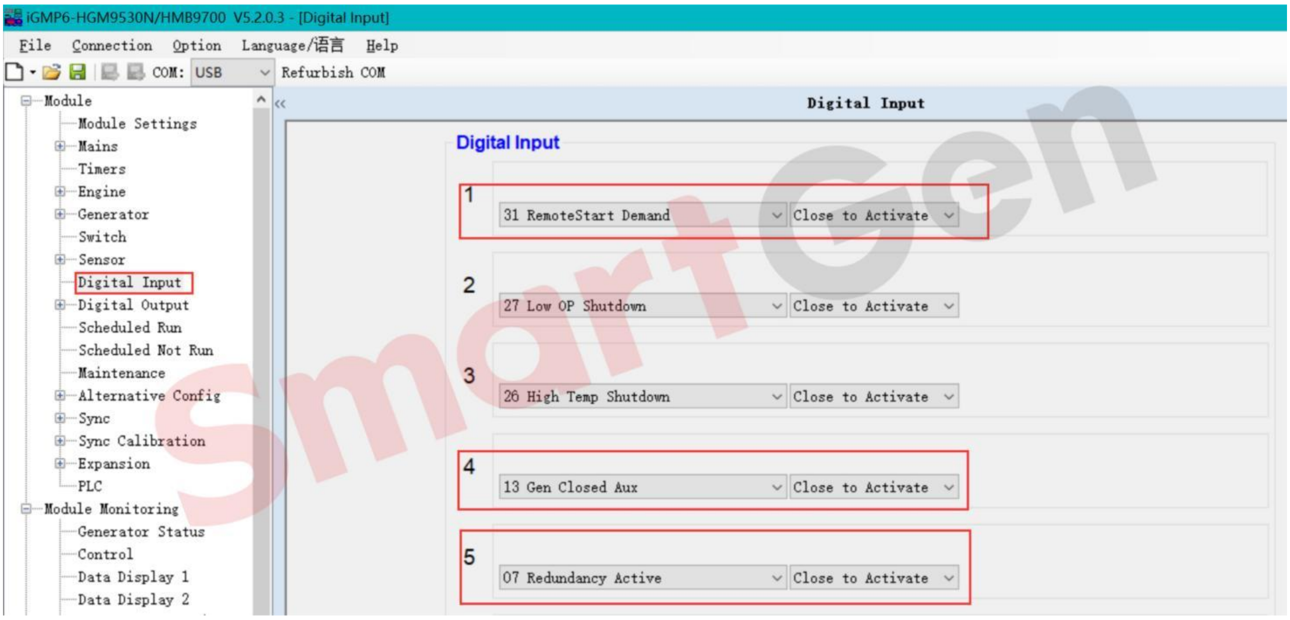


Fig. 50 HGM9530N Redundancy Mode Digital Inputs Setting

2.5 Outputs Setting

2.5.1 HGM9510 Gens Parallel Mode Application Digital Outputs Setting

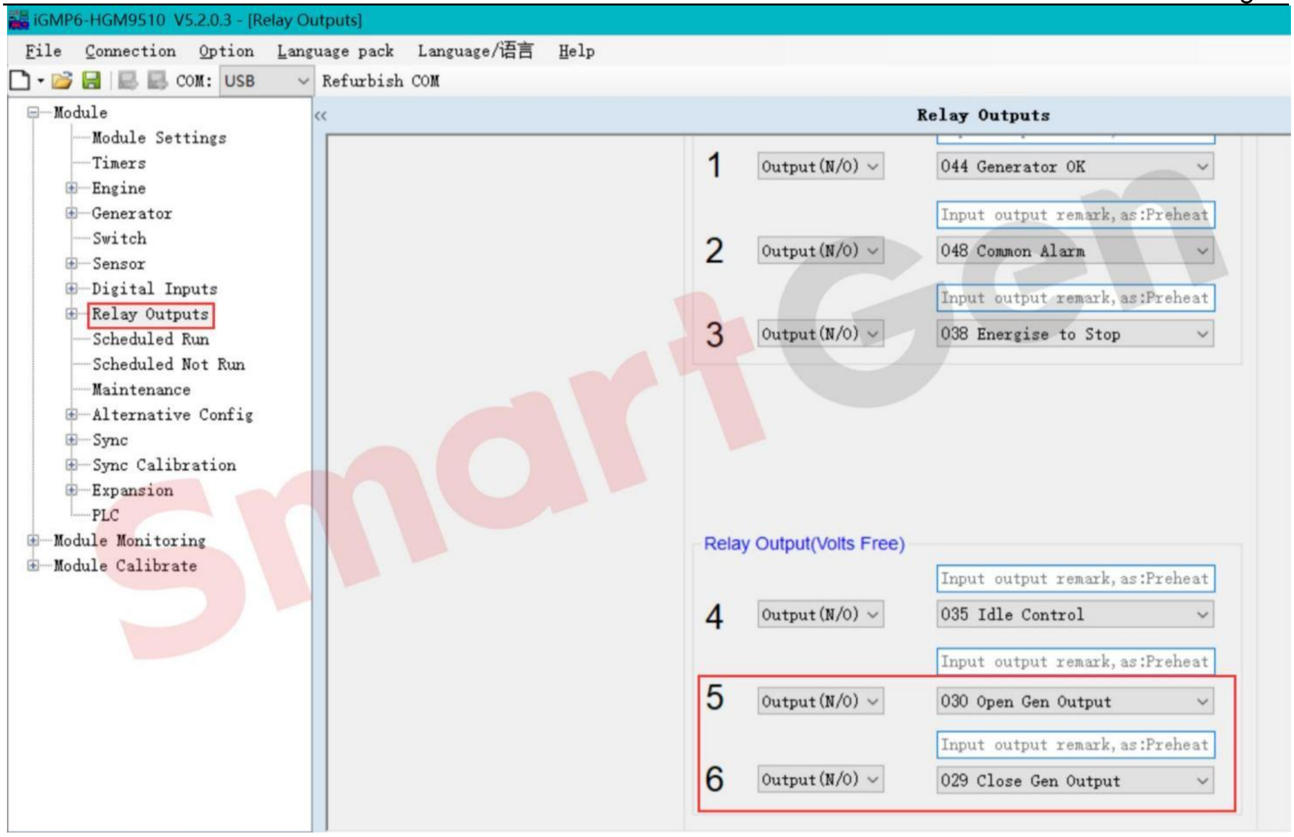


Fig. 51 HGM9510 Gens Parallel Mode Digital Outputs Setting

2.5.2 HGM9520 Single Genset Parallel with Mains Application Digital Outputs Setting

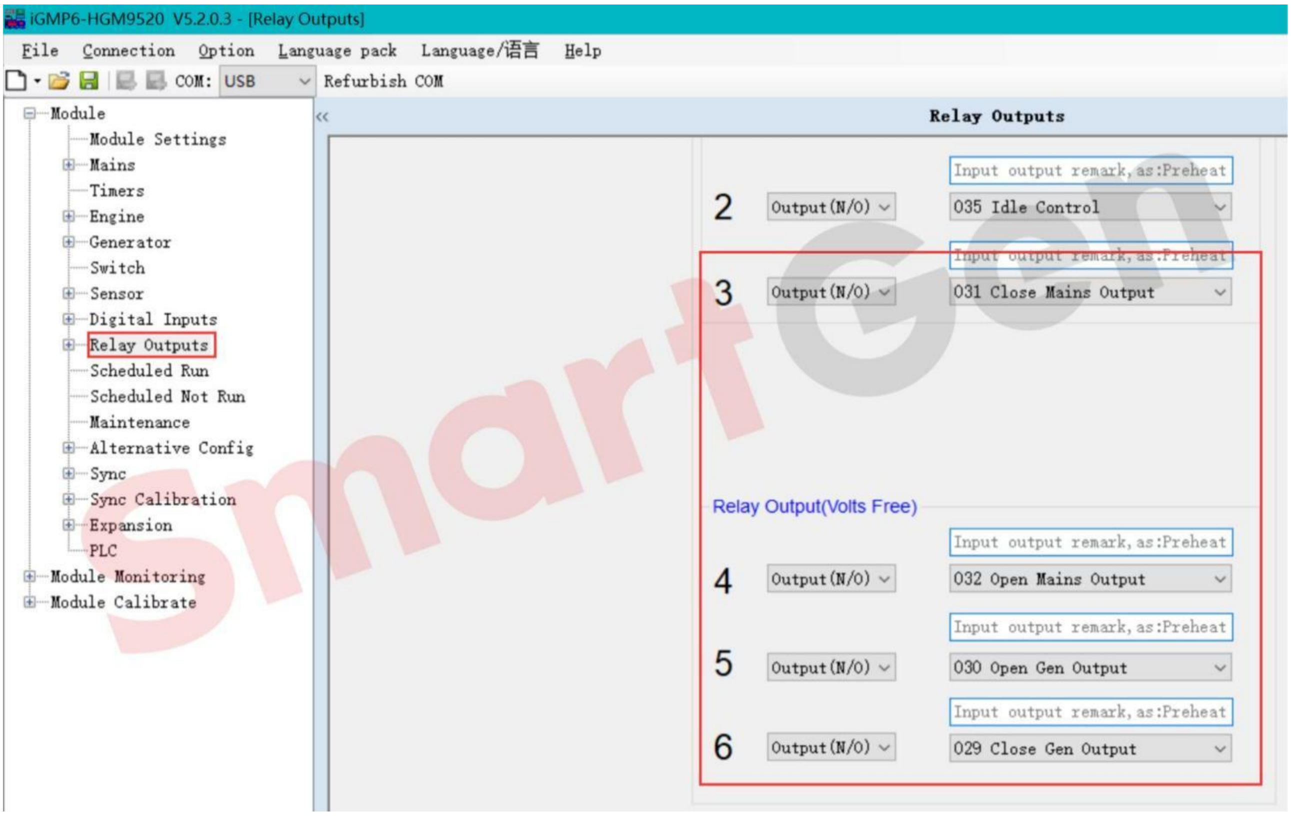


Fig. 52 HGM9520 Single Genset Parallel with Mains Digital Outputs Setting

2.5.3 HGM9510N Fast Parallel Mode Application Digital Outputs Setting

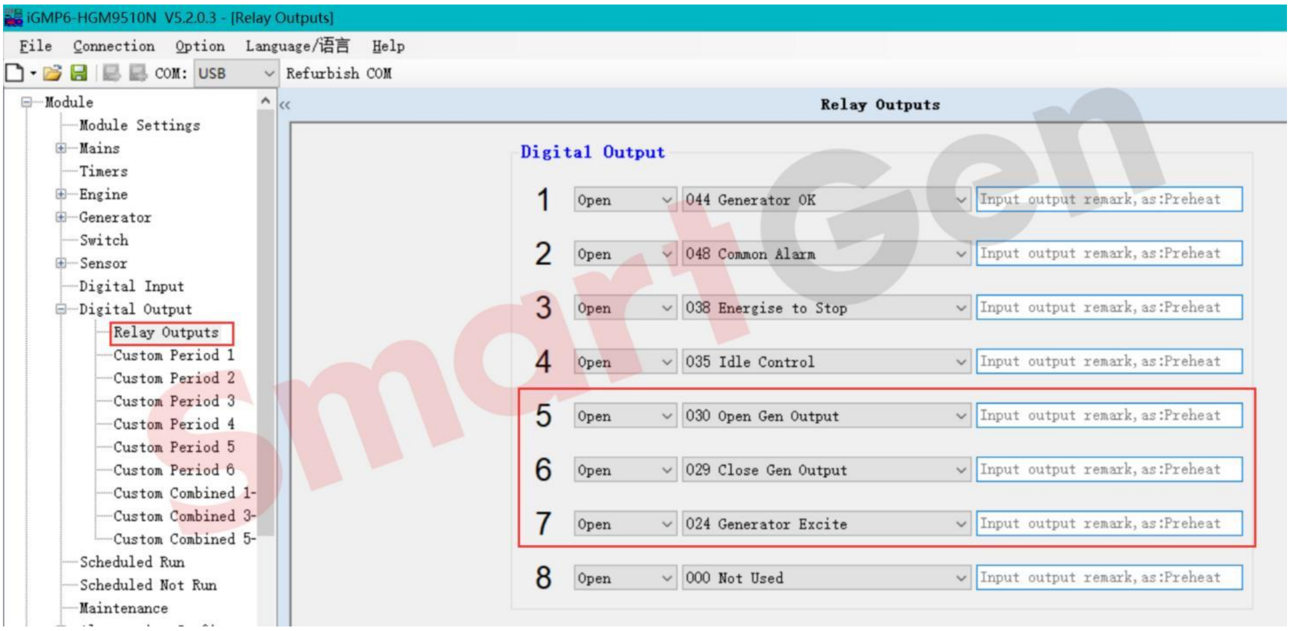


Fig. 53 HGM9510N Fast Parallel Mode Digital Outputs Setting

2.5.4 HGM9560 Gens Busbar Parallel with Mains Application Digital Outputs Setting

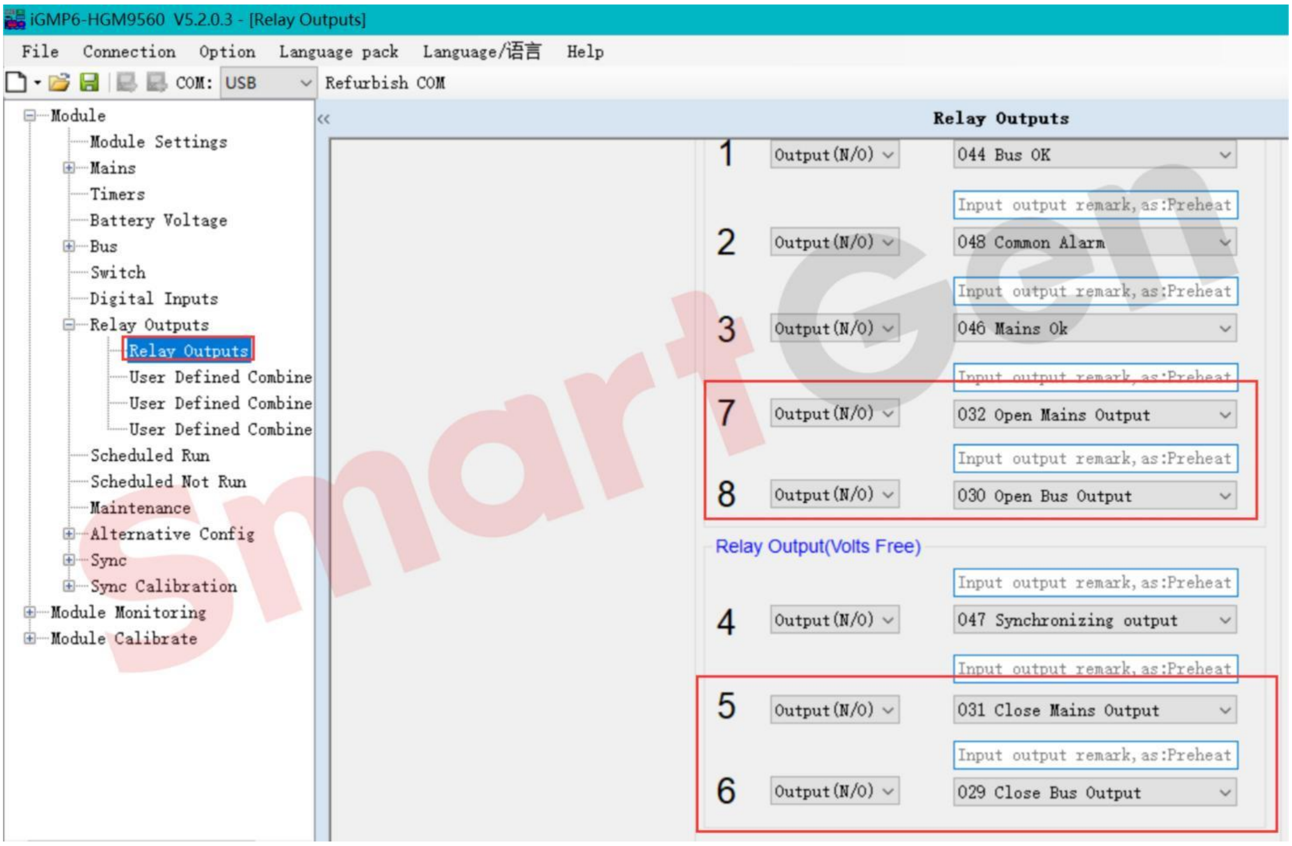


Fig. 54 HGM9560 Gens Busbar Parallel with Mains Digital Outputs Setting

2.5.5 HGM9580 Busbar Parallel Application Digital Outputs Setting

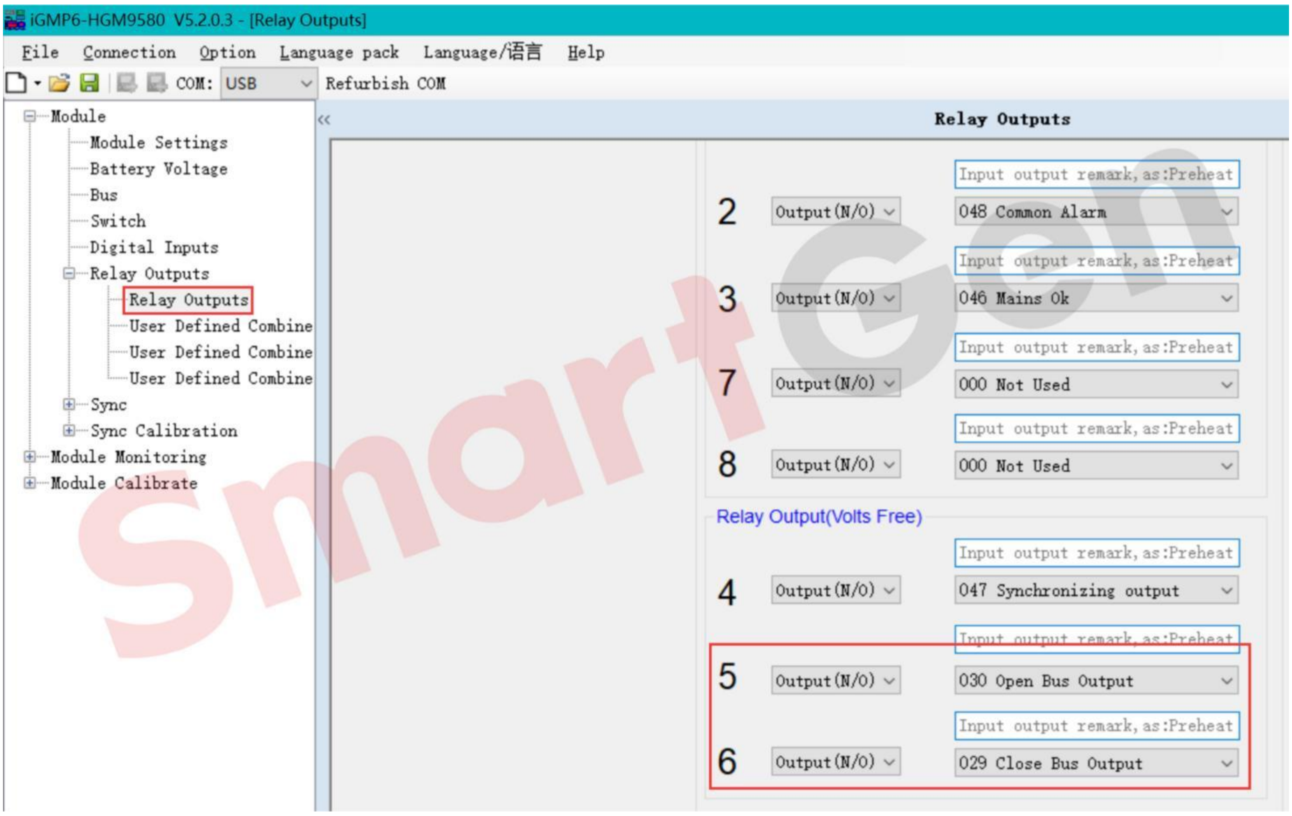


Fig. 55 HGM9580 Busbar Parallel Application Digital Outputs Setting

2.5.6 HGM9530N Redundancy Control Mode Application Digital Outputs Setting

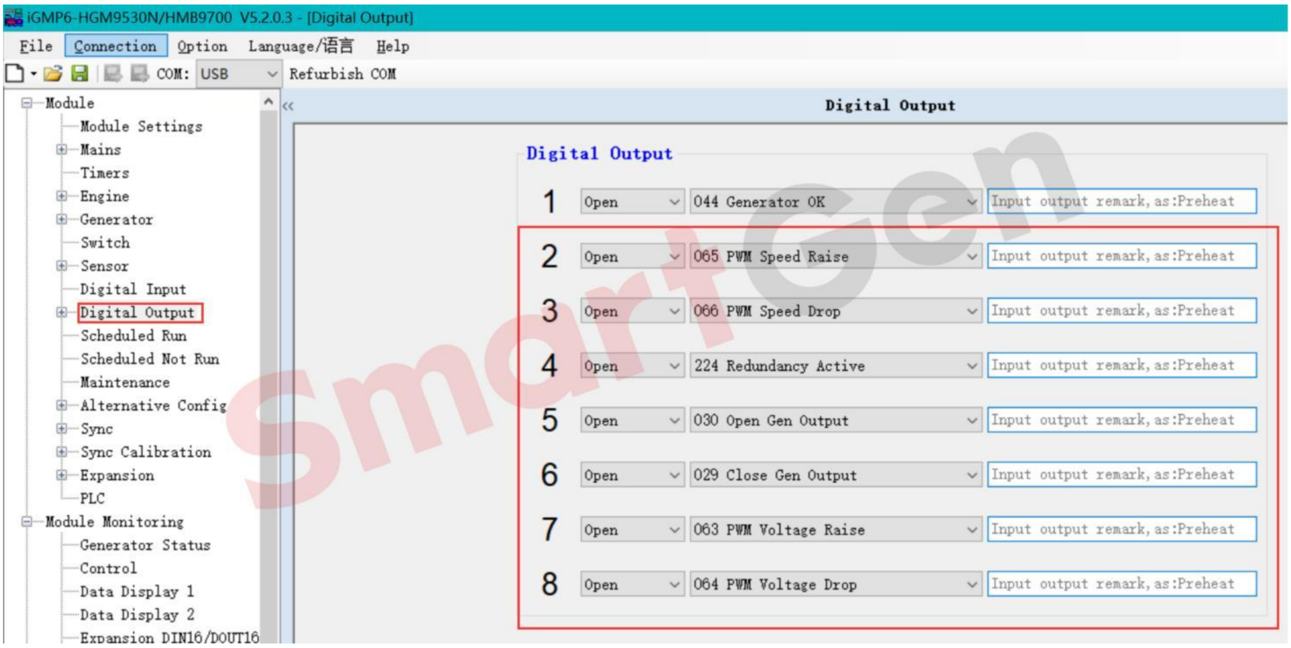


Fig. 56 HGM9530N Redundancy Control Mode Application Digital Outputs Setting

2.6 Sync Setting

2.6.1 HGM9510/HGM9530N Start Sets as Load Requires Application Multi Sync Setting

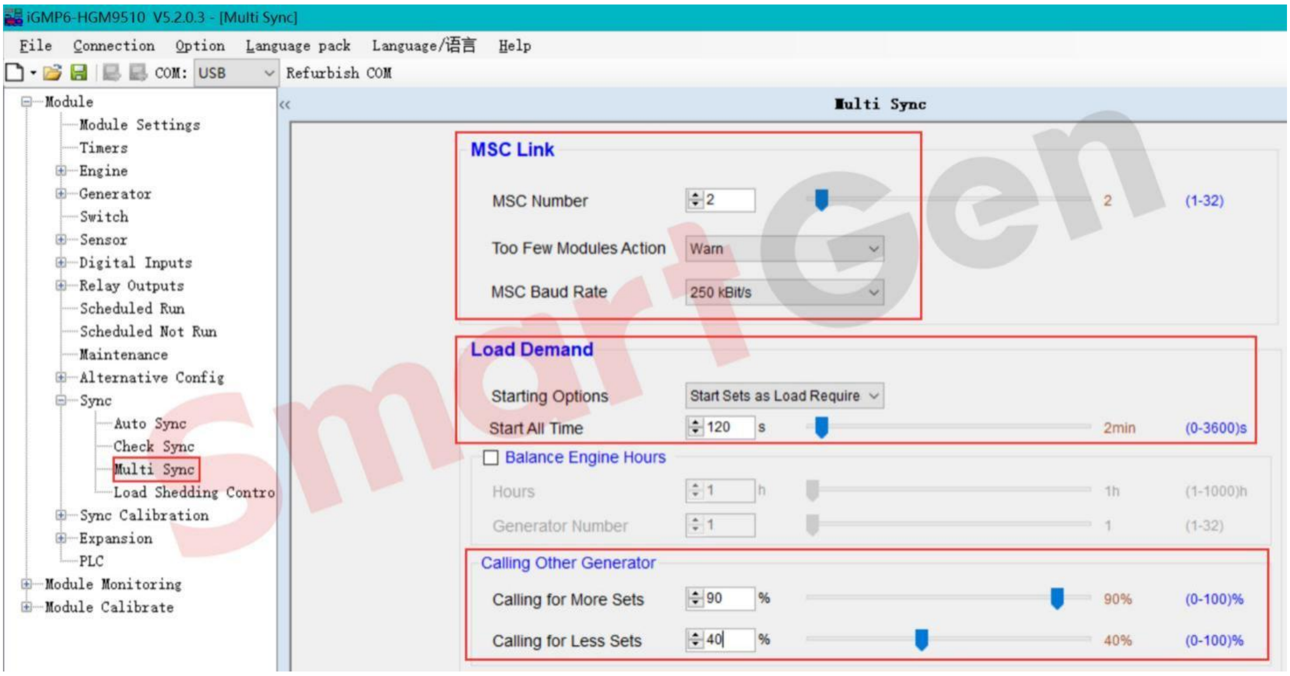


Fig. 57 Start Sets as Load Requires Setting

2.6.2 HGM9510 Start All Sets Initially Application Multi Sync Setting

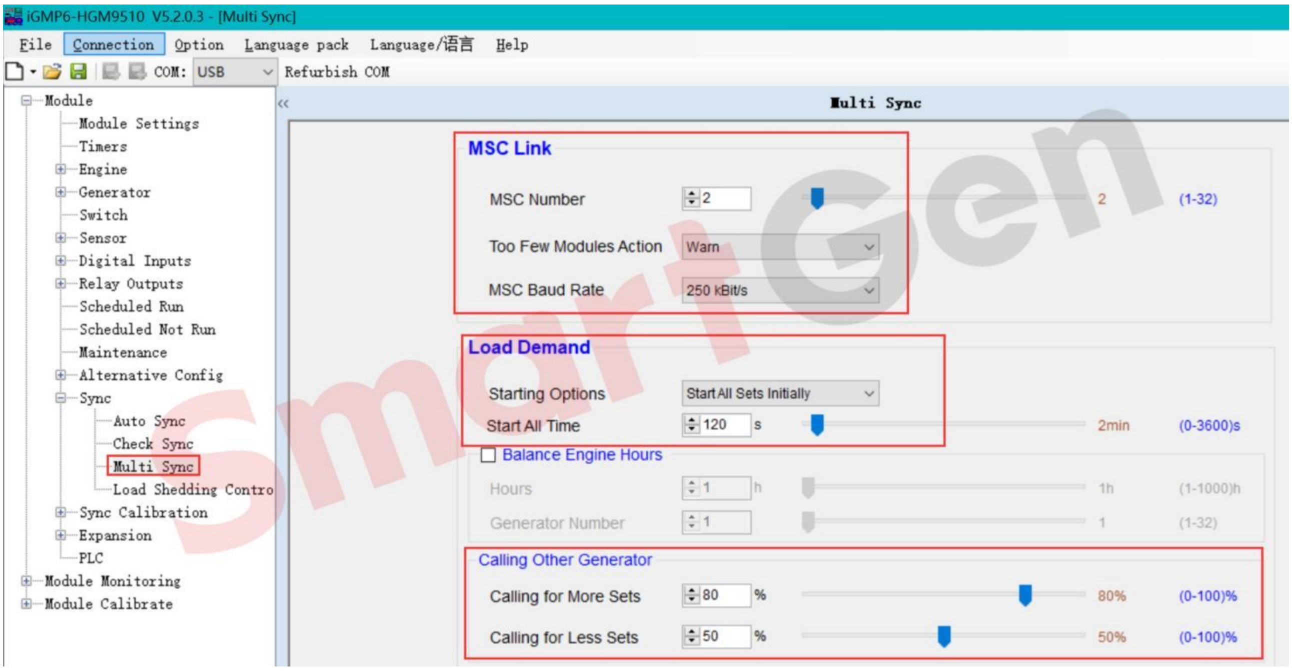


Fig. 58 Start All Sets Initially Setting

2.6.3 HGM9510 Balanced Engine Running Time Application Multi Sync Setting

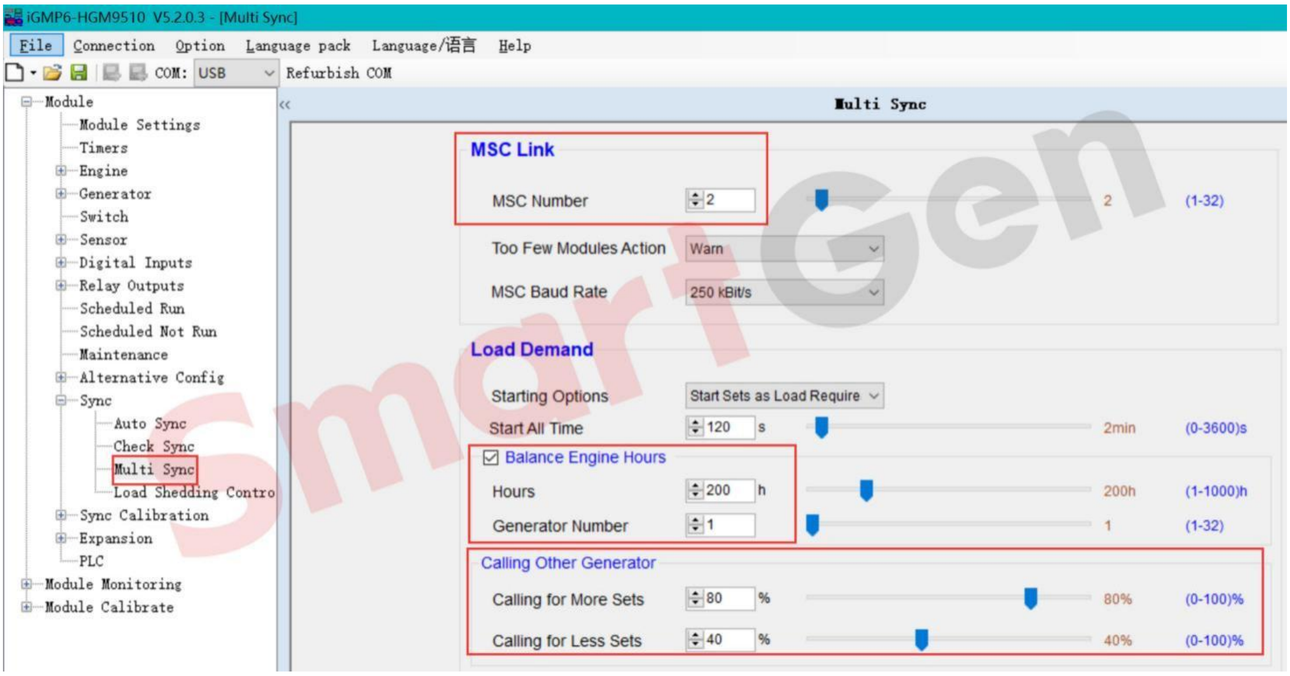


Fig. 59 Balanced Engine Running Time Setting

2.6.4 HGM9510N Fast Parallel Mode Application Multi Sync Setting

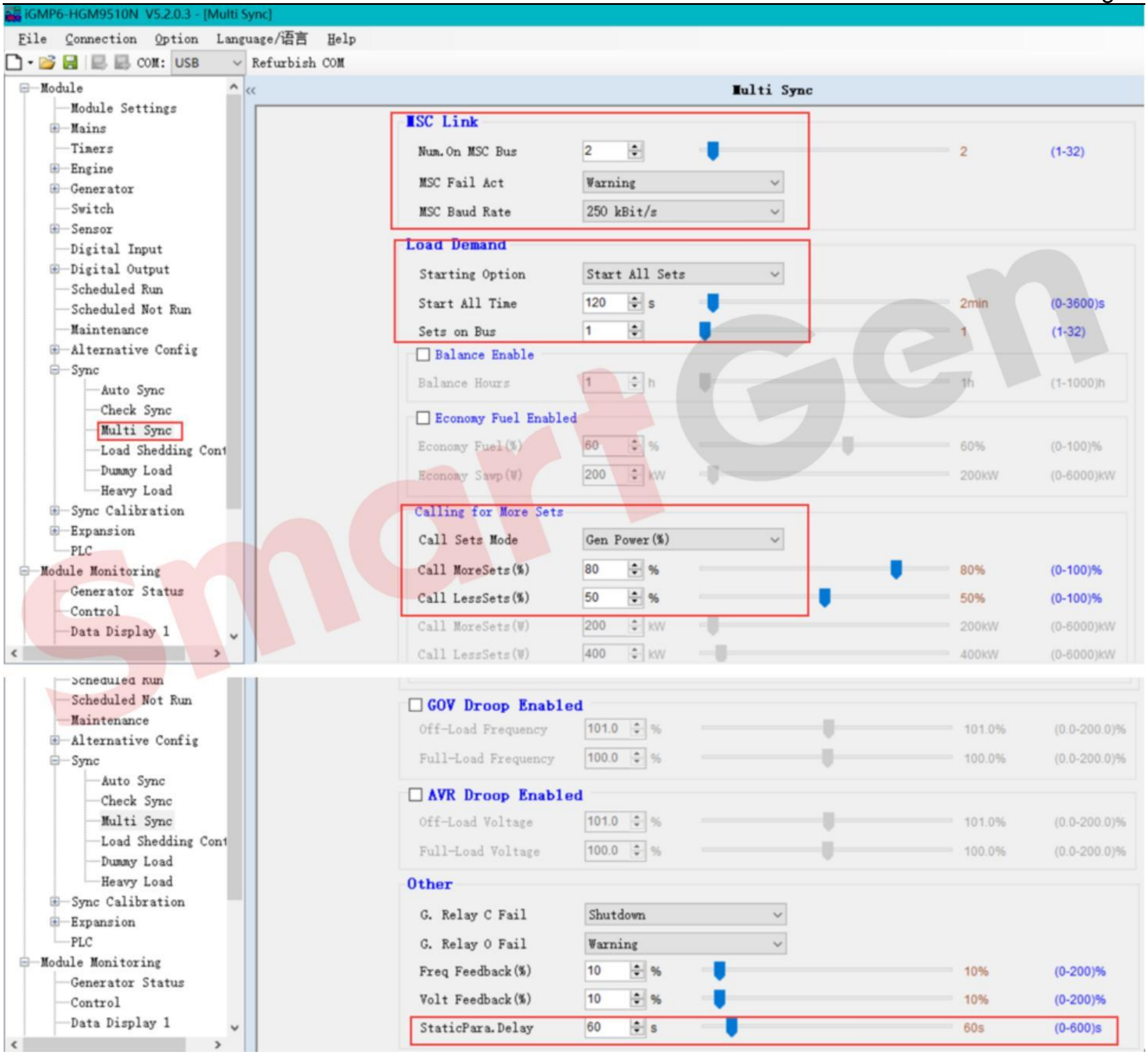


Fig. 60 Fast Parallel Mode Setting

2.6.5 HGM9510N Economical Fuel Consumption Parallel Application Multi Sync Setting

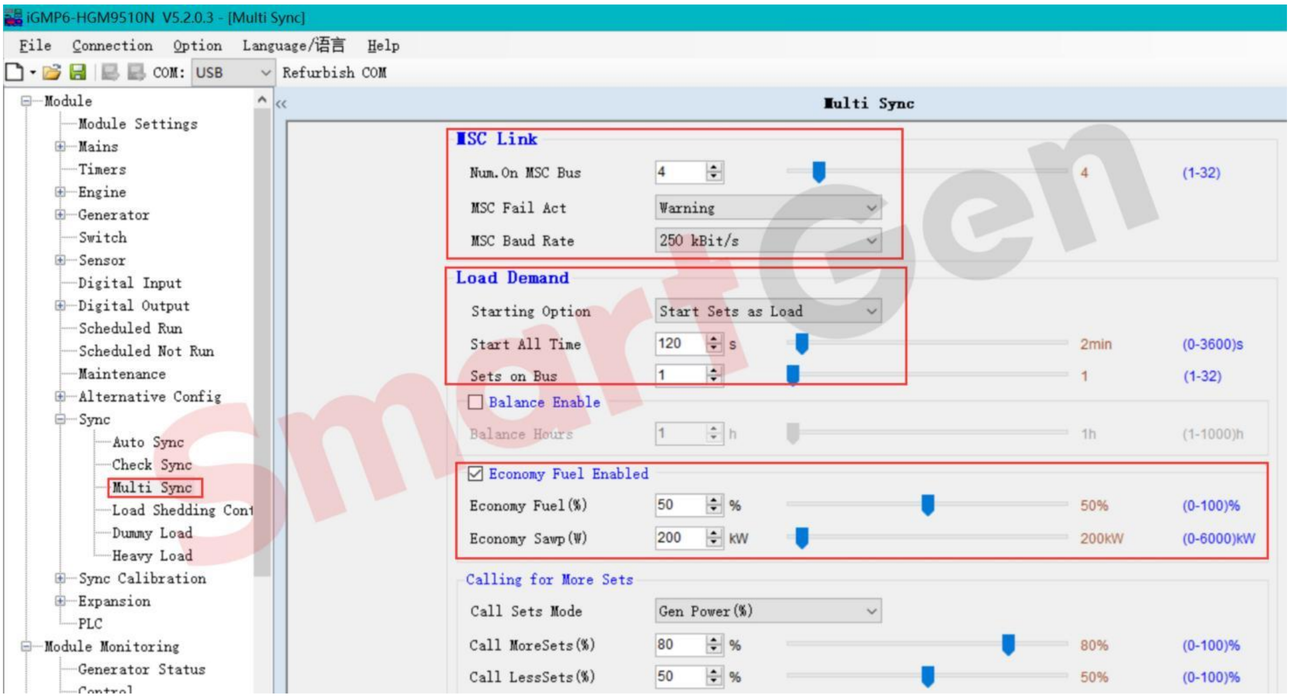


Fig. 61 Economical Fuel Consumption Parallel Setting

2.6.6 HGM9560 Gens Busbar Parallel with Mains Application Multi Sync Setting

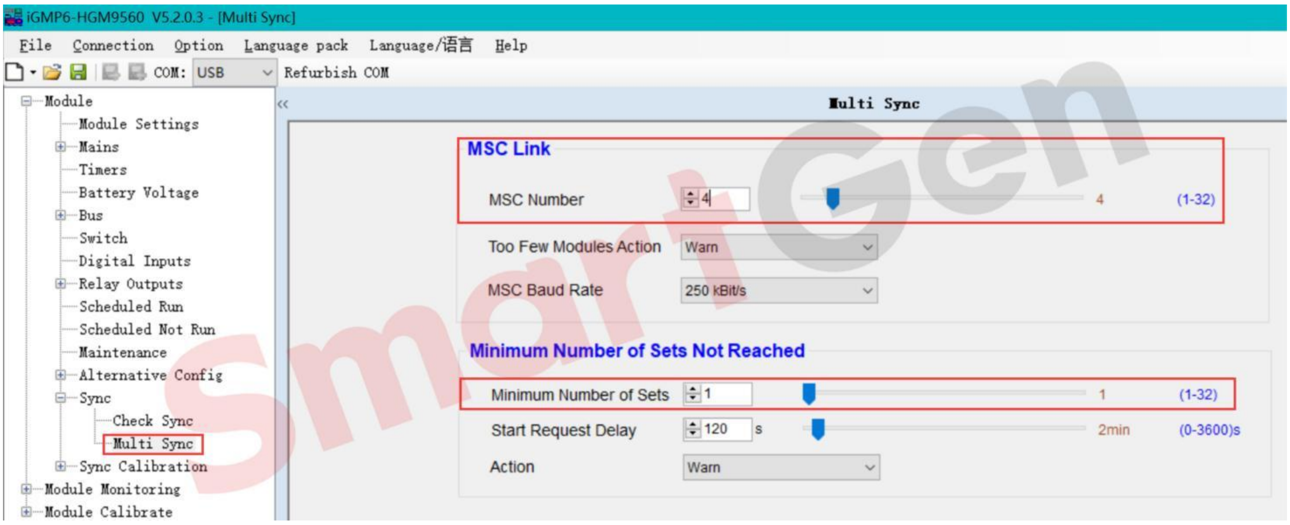


Fig. 62 Gens Busbar Parallel with Mains Setting

2.6.7 HGM9580 Busbar Parallel Application Multi Sync Setting

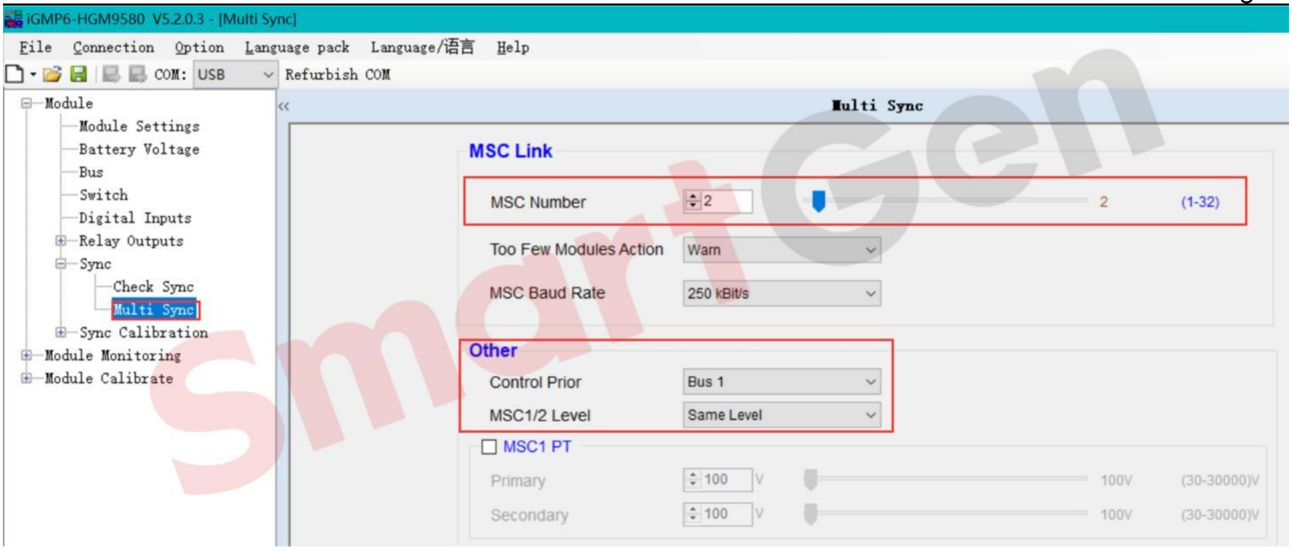


Fig. 63 HGM9580 Busbar Parallel Setting

2.7 Sync Calibration Setting

2.7.1 MSC Setting

Fig. 64 MSC Setting

2.7.2 Load Mode/Active Power Output /Reactive Power Output Setting

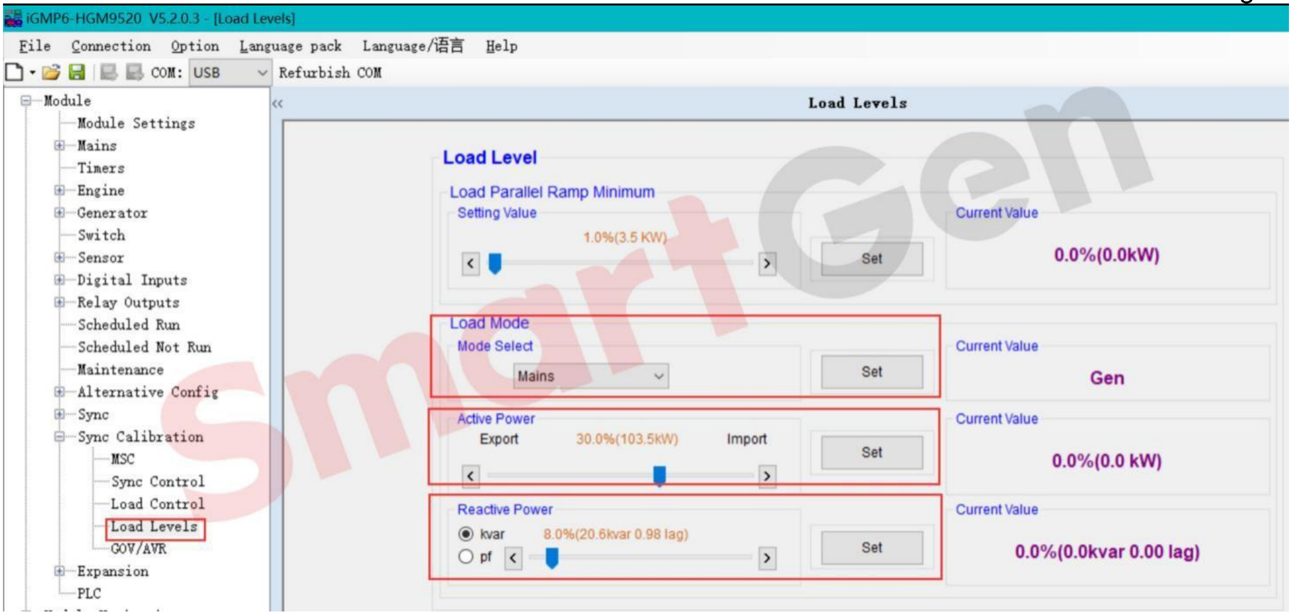


Fig. 65 Load Levels Setting

2.7.3 GOV/AVR Setting

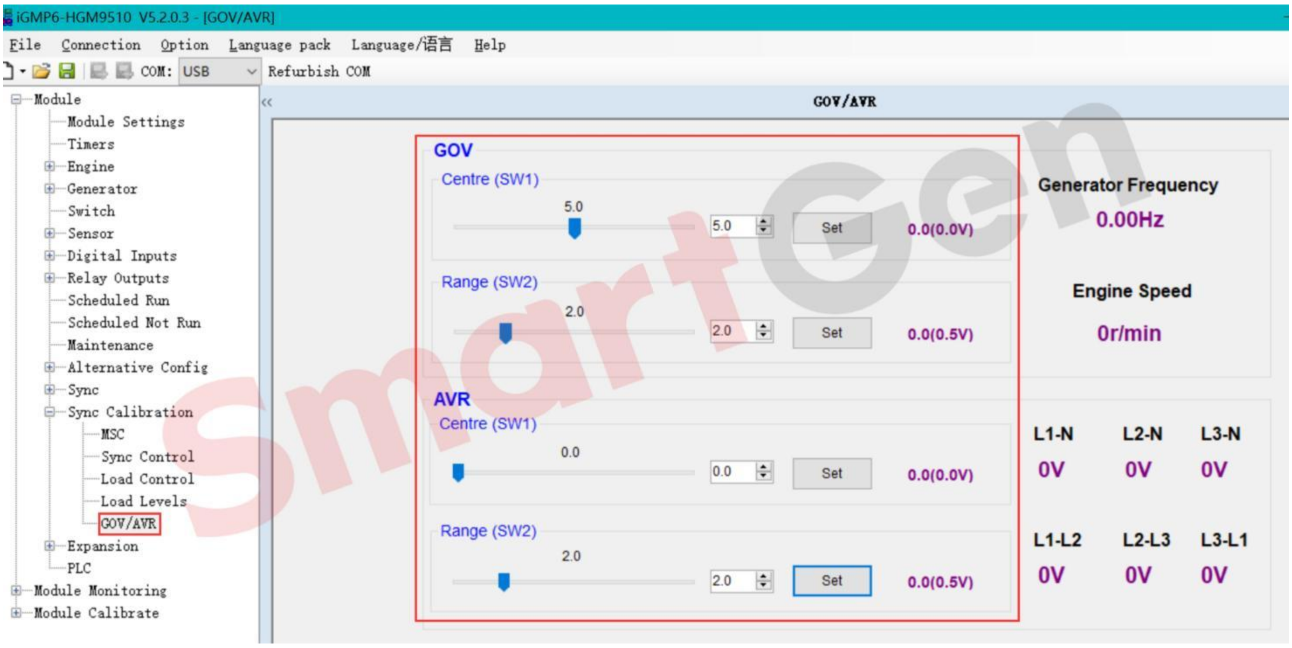


Fig. 66 GOV/AVR Setting

2.8 Bus Setting

2.8.1 AC System/Bus Rated Voltage/Bus Rated Frequency

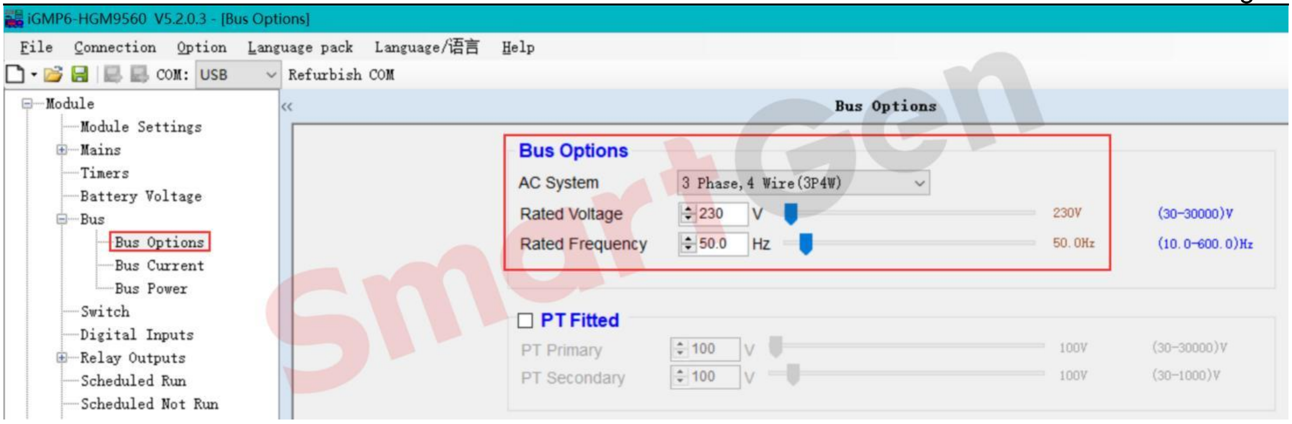


Fig. 67 Bus Options

2.8.2 Bus Current Setting

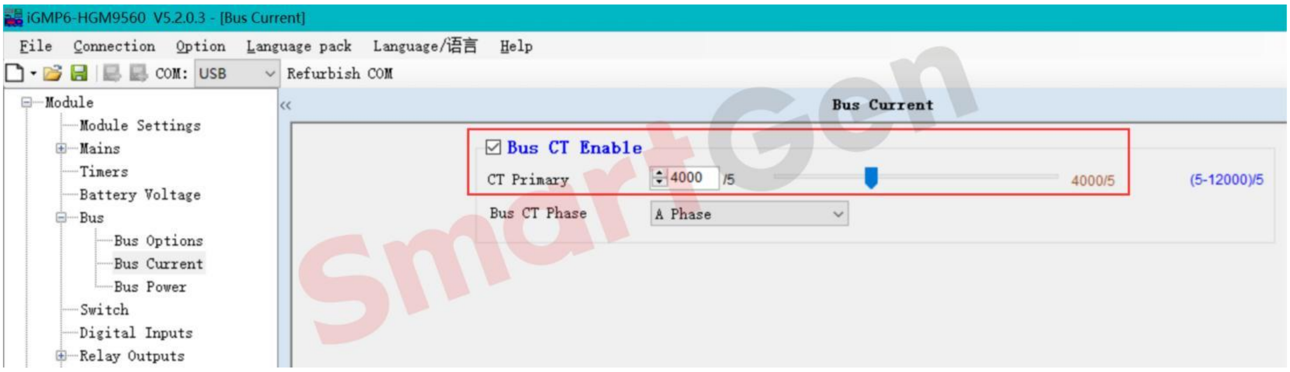


Fig. 68 Bus CT Selection

2.8.3 Bus Full Load Rated Active Power / Bus Full Load Rated Reactive Power Setting

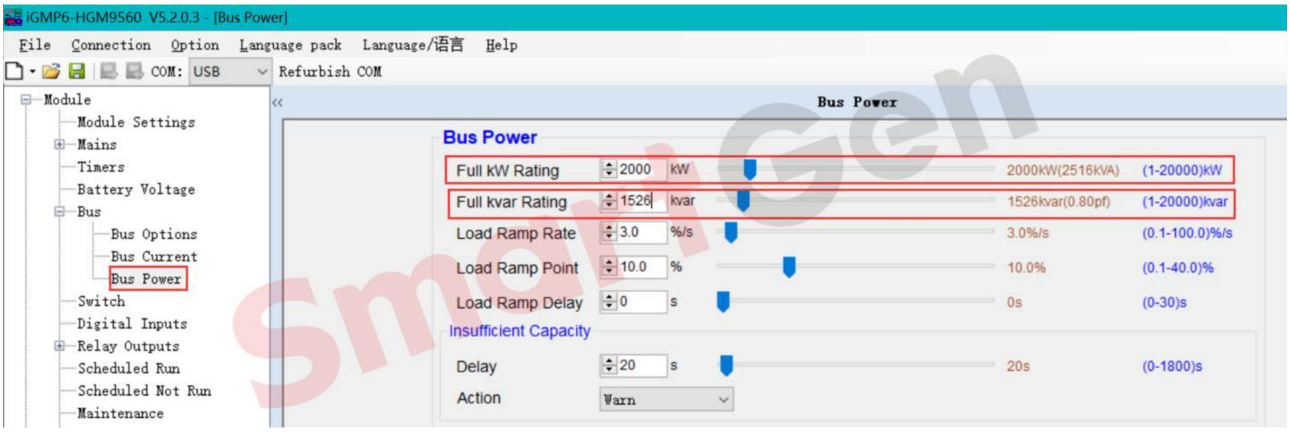


Fig. 69 Bus Power Setting

2.9 Module Setting

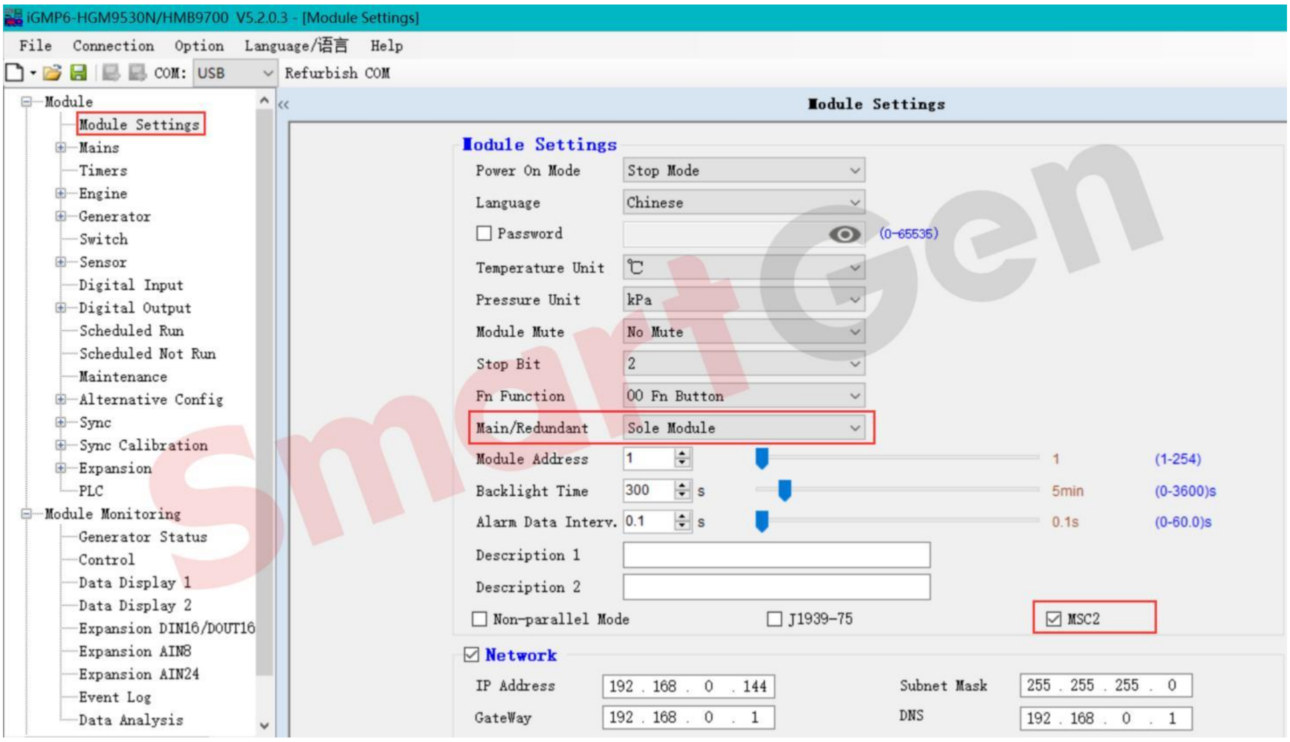


Fig. 70 HGM9530N Redundancy Mode Setting

3 Commissioning Guide

3.1 Precautions Before Paralleling

- Know the Engine Type: EFI or non-EFI. For EFI engine, please refer to ＜ EFI Engine Parameter Setting ＞ for wiring and setting. If there is no corresponding ECU wiring and configuration table or communication is abnormal, please contact the engine manufacturer to confirm whether the parallel point of the engine itself has been opened and obtain the correct wiring method. For non-EFI engine, please check the brand and model of the governor: For example, the speed control unit of Cummins EFC needs to connect with a 120kΩ resistor for automatic speed regulation. For ordinary engine speed control unit, it is necessary to understand how to connect the terminals on the unit to the controller, and set SW1 and SW2 values on the controller according to the voltage adjustment signal range of different governors. Parameters and wiring can be set according to ＜ HGM9500 Controller GOV/AVR Parameter Setting＞ or ＜ HGM9500N Controller GOV/AVR Parameter Setting＞ EFI engine needs to set the values of SW1 and SW2 on the controller according to the voltage regulation range of different ECU automatic speed regulation.
- Know the brand and model of the generator AVR: Please refer to the AVR part wiring and setting of ＜ HGM9500 Controller GOV/AVR Parameter Setting ＞ or ＜ HGM9500N Controller GOV/AVR Parameter Setting ＞ If there is no corresponding AVR model in the scheme, please contact the genset manufacturer to obtain the correct wiring method and set the voltage regulation range. Set the values of SW1 and SW2 on the controller or software according to the correct voltage regulation range.
- If necessary, the customer can submit the wiring diagram of HGM series parallel controller to the relevant SmartGen technicians, who will assist in reviewing whether the wiring diagram is correct and setting the program in advance to save the customer's time for setting programs on site.
- Two 120Ω resistors and two 120KΩ resistors have been equipped in the controller packaging box. The 120Ω resistor is used to connect between the MSC communication ports H and L of the head controller and between the MSC communication ports H and L of the tail controller. The 120KΩ resistor is used to connect in series between Terminal 8 of the EFC series GOV of Cummins and Terminal 31 of the controller.

- For MSC communication cable, it is recommended to use high-quality 120Ω impedance cable. If ordinary communication cable is used, MSC communication may be abnormal (SmartGen has provided two 120Ω resistors before leaving the factory, and 120Ω resistors have been added in some new models of hardware).
- When wiring, try not to put the MSC communication cable in the same trunking as the wire with strong current to prevent interference.
- The main setting items of the parallel controller are shown in the table below.

Table 31 Main Setting Items of Parallel Controller

Item	**Parameters**						
	1	2	3	4	5	6	7
Engine Setting	Engine Type	Flywheel Teeth	Rated Speed				
Generator Setting	Power System	Rated Voltage	Rated Frequency	Ct	Rated Current	Rated Active Power	Rated Reactive Power
Analog Sensors Setting	Temperature	Oil Pressure	Liquid Level				
Digital Input Ports	Remote Start	Low Oil Pressure Shutdown	High Temperature Shutdown	Gen Close Status Input			
Digital Output Ports	Idle Control	Open Gen Output	Close Gen Output				
Multi Sync Setting	Num. On MSC Bus						
Sync Calibration	MSC ID	Module Priority	Load Mode select	GOV/AVR			

All the above Parameters are set according to the site use.

3.2 Preparation before Parallel

a) Check whether the battery power is sufficient to ensure that the "Starting motor" starts, and then start the engine. If the starting instantaneous voltage is lower than 10V (12V power supply battery system) and 20V (24V power supply battery system), the battery has lost power.

b) Check whether the diesel, oil and coolant of the engine are normal.

c) Before starting the engine, remove the air in the fuel injection pump through the manual fuel injection valve to ensure the smooth start of the engine.

d) Check whether the wiring between the controller and the periphery is correct according to the circuit diagram to avoid wrong wiring; mainly check the MSC communication line (shielded wire) from the controller to the GOV, AVR and the unit, and ensure that the shielded wire is fully grounded, Close Gen Output, Open Gen Output, Gen Close Status Input, and the whole system is connected to ground.

e) Check whether the controller is well grounded (connected to the generator set grounding pile head).

f) Configure the controller parameters according to the actual situation of the generator unit.

g) Manually start the generator by the controller. After the generator runs normally, adjust the rated speed and rated voltage of the generator.

h) By manually closing or opening, confirm whether the opening and closing of the controller control switch is normal.

i) The speed regulation and voltage regulation of single unit test are normal. Before the switch is closed, properly change the rated frequency and rated voltage; after the switch is closed, whether the power generation frequency and voltage are adjusted to the set rated value; after the switch is opened, restore the rated frequency and rated voltage.

j) Before paralleling, make sure that the single unit is running normally, and adjust the gain and stability of the generator.

k) After manual loading, observe whether the generator operates normally.

l) After the manual parallel debugging is normal, adjust the controller to the Auto mode, and realize the automatic parallel after the remote startup input is valid.

3.3 Four Steps of Parallel

3.3.1 Description

Three elements of parallel: voltage, frequency, and phase.

As the name suggests, three conditions must be met in order to realize the parallel of multiple units: the AC power generation voltage is within the synchronization range of multiple parallel units (for example, the voltage difference is within ±3V), and the power generation frequency is within the synchronization range of multiple parallel units (for example, the frequency difference is within ± 0.1Hz), the phases of the power generation of multiple units should be consistent with 0°-120°-240°, and the phase difference should be guaranteed to be within a certain range, for example: within 10 degrees. The smaller the deviation of the three elements of the

parallel operation of multiple units, the smaller the circulation generated immediately after the parallel, and vice versa.

3.3.2 Step 1: Speed Regulation and Voltage Regulation Control

3.3.2.1 Speed Regulation Control

Take the ESD5500 GOV as an example, wire and set the values of SW1 and SW2 of GOV.

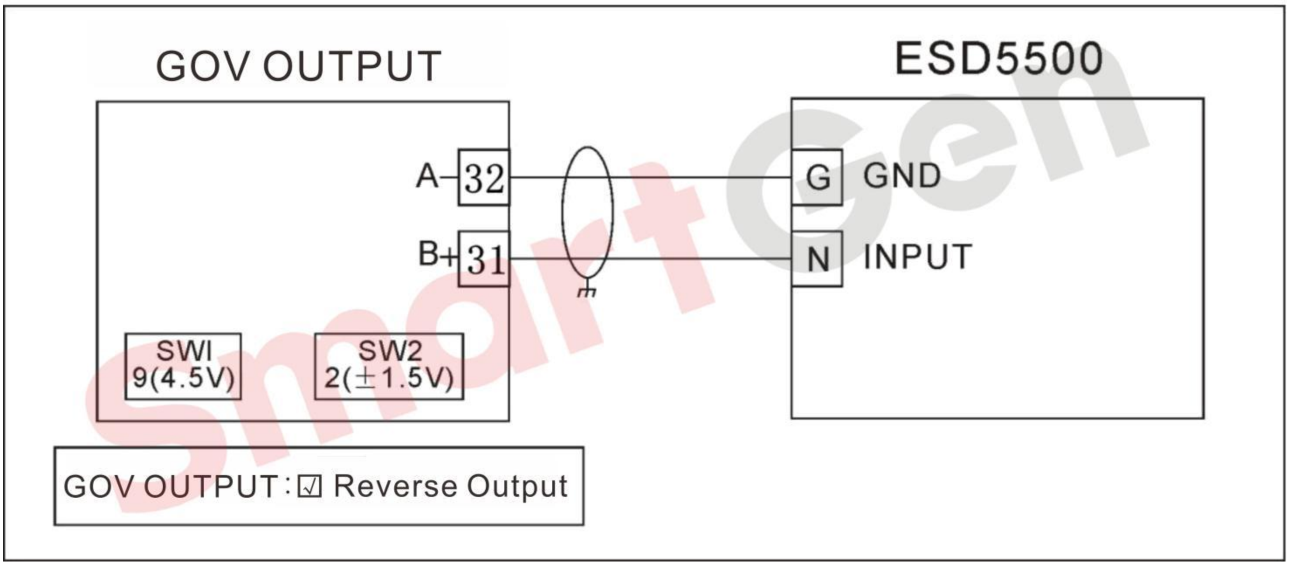


Fig.71 GOV parameter setting and wiring diagram

Adjust the SW1 value of GOV (speed regulation control) in synchronization setting.

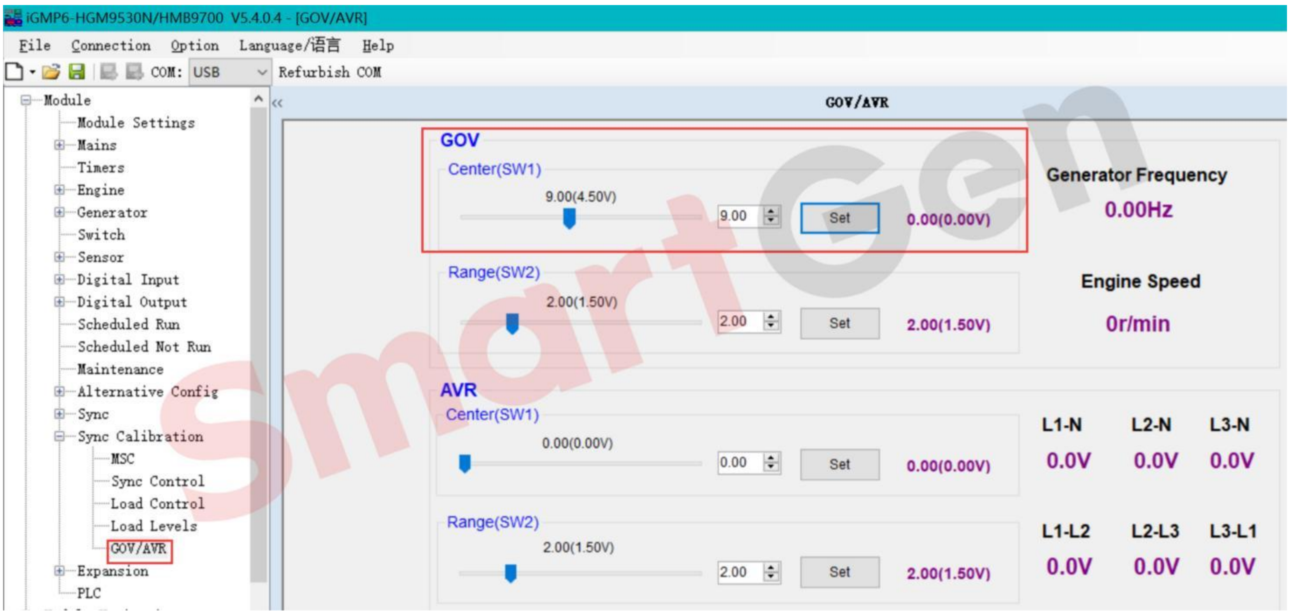


Fig.72 Adjust SW1 of GOV

Adjusting the SW1 of GOV (speed regulation control) has two purposes, one is to judge whether the GOV itself is normal; the other is to judge whether the wiring between the controller and the GOV is correct.

——If the SW1 value is increased, the speed increases accordingly; turn down the SW1 value and the speed decreases accordingly. This indicates that the wiring is correct.

——If the SW1 value is increased, the speed decreases; turn down the SW1 value and the speed increases. This indicates that the wiring between the controller and GOV is wrong.

Solutions for wiring errors:

——Change the position of the two GOV wires.

——Select Output Reverse.

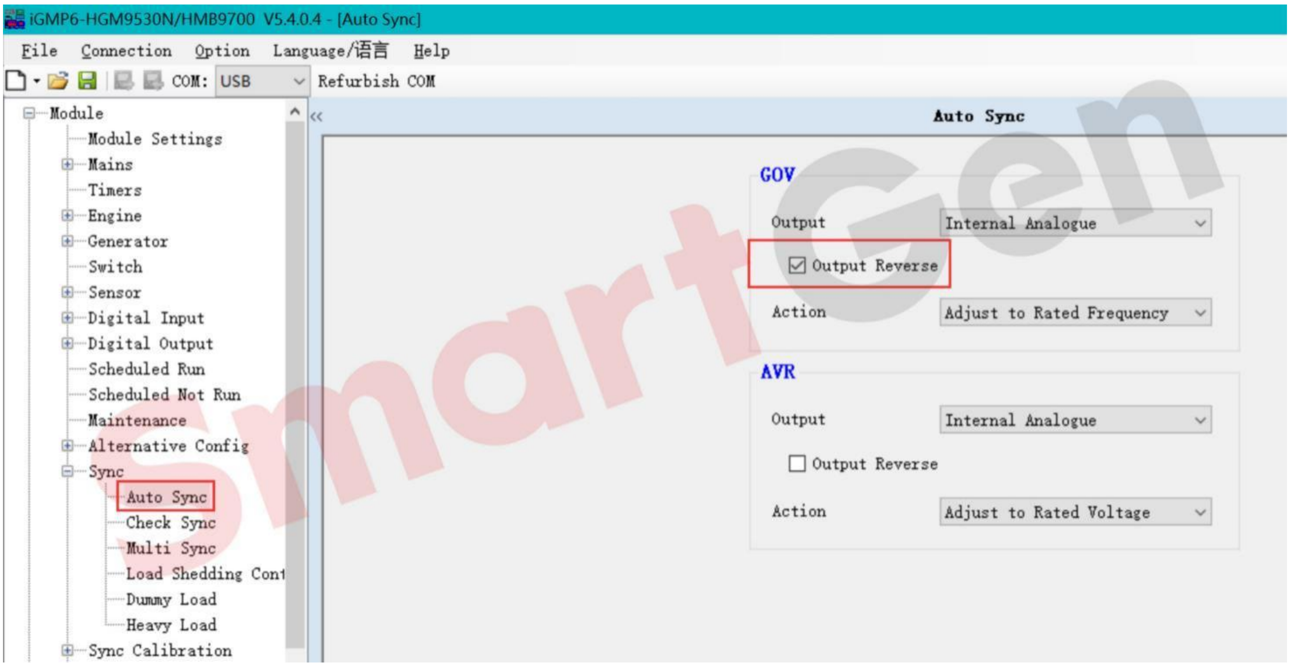


Fig.73 GOV Output Reverse enable

The rated frequency of the engine speed shall be adjusted for a single unit, and the adjustment range is between ±1Hz. When the frequency changes, the speed of the engine changes accordingly. The purpose is to make the speed adjustment range of the controller relatively wide when finding the synchronization point (applicable to different engines in parallel). For example, the power of the unit is 30kW, the number of teeth is 130, the rated frequency of the engine is 50Hz, the speed is 1500rpm, SW1 of GOV is 9 and SW2 is 2.

First increase the frequency by 1Hz, change it to 51Hz and write it into the controller.

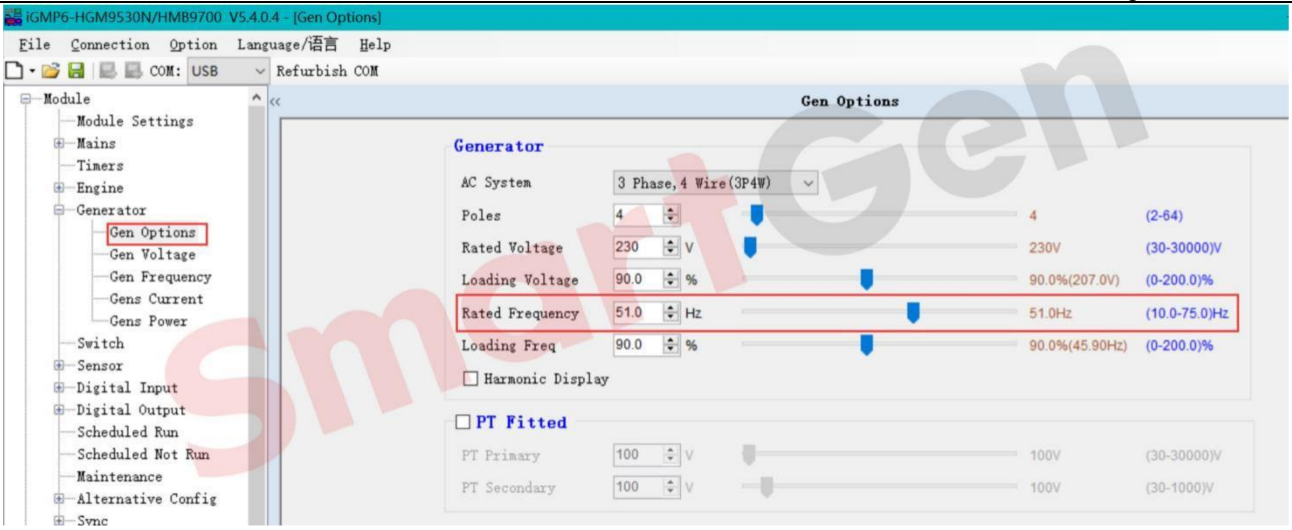
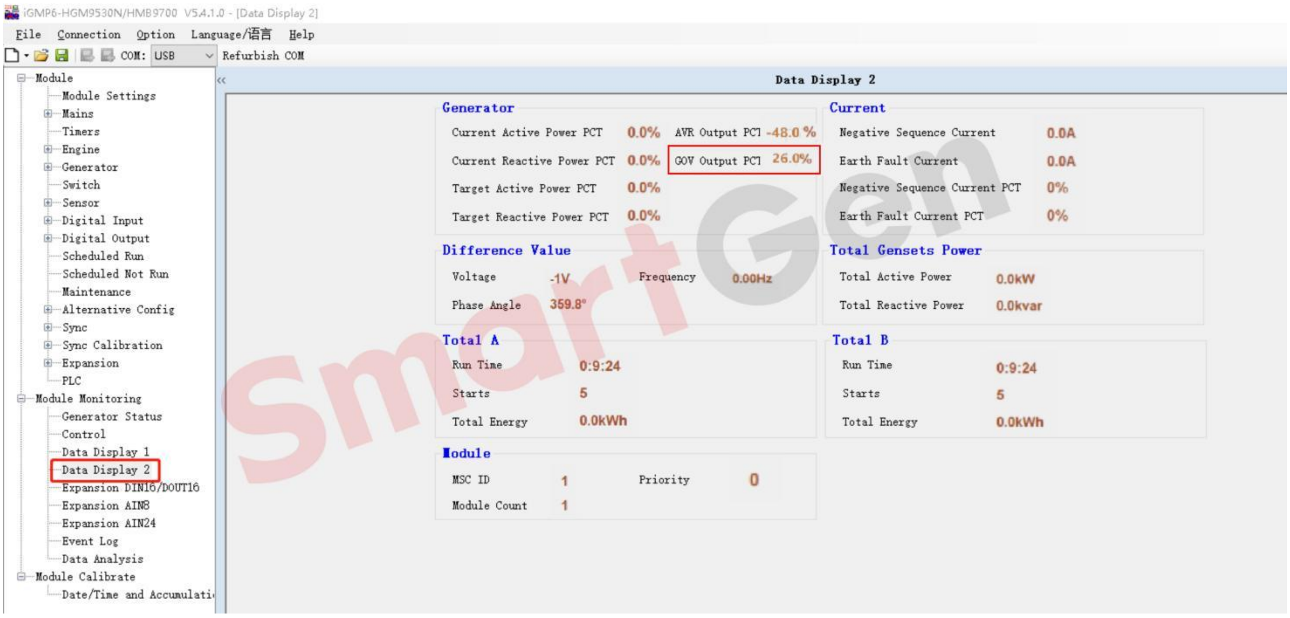


Fig.74 Set the rated frequency to 51HZ

The controller is turned on in manual mode. After the unit is running normally, press the closing button, the generator switch is closed, and the frequency slowly rises to 51HZ. At this time, the GOV output percentage should be 26%, and the corresponding speed is 1530rpm and 51Hz.



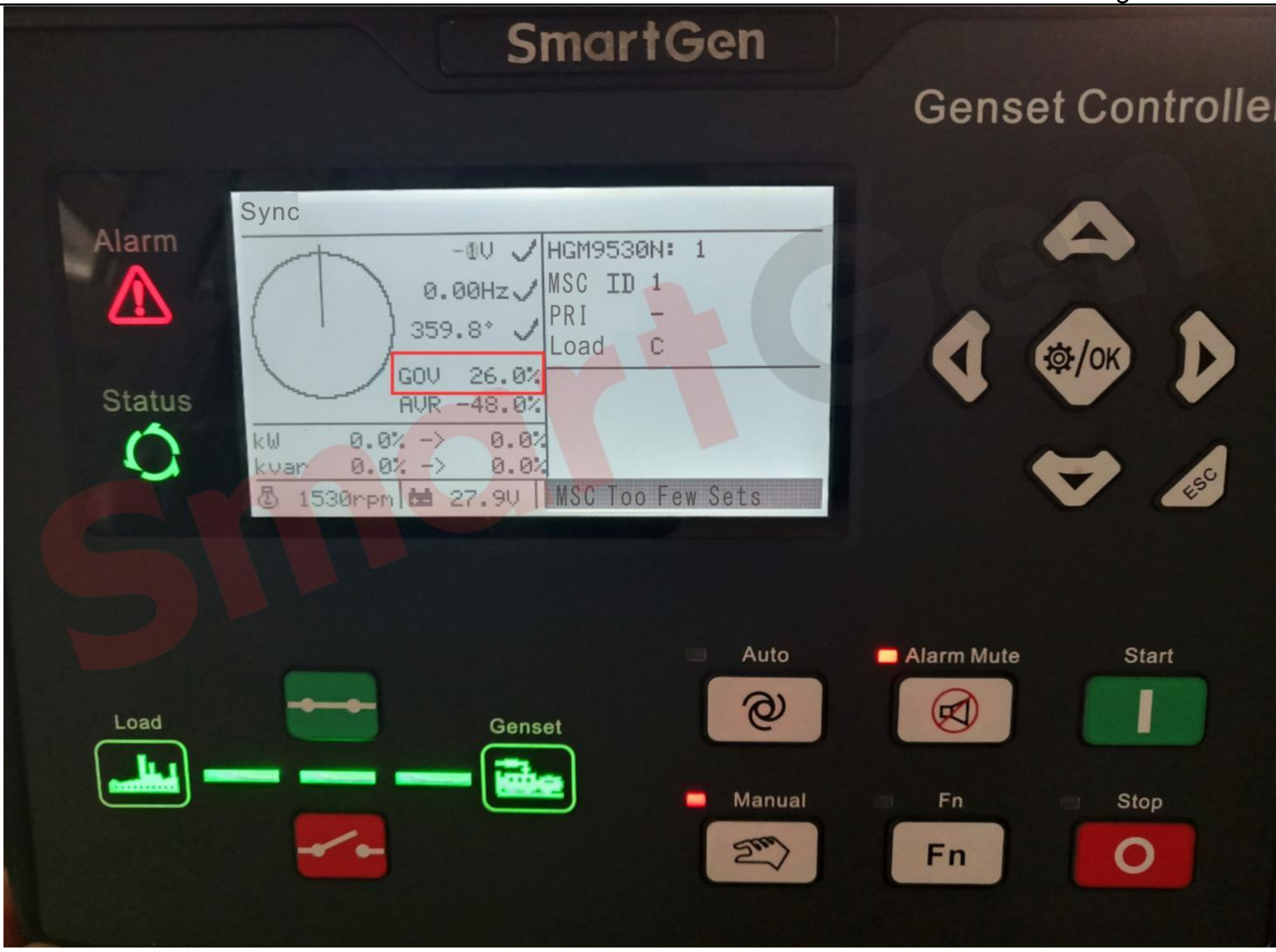


Fig.75 GOV output percentage at rated frequency 51HZ

If the GOV output percentage is not 26.0%, adjust the value of SW2 until the GOV output percentage reaches 26.0% corresponding to the speed of 1530rpm. The specific settings are shown in Figure 76, and then press the opening button to open the generator switch.

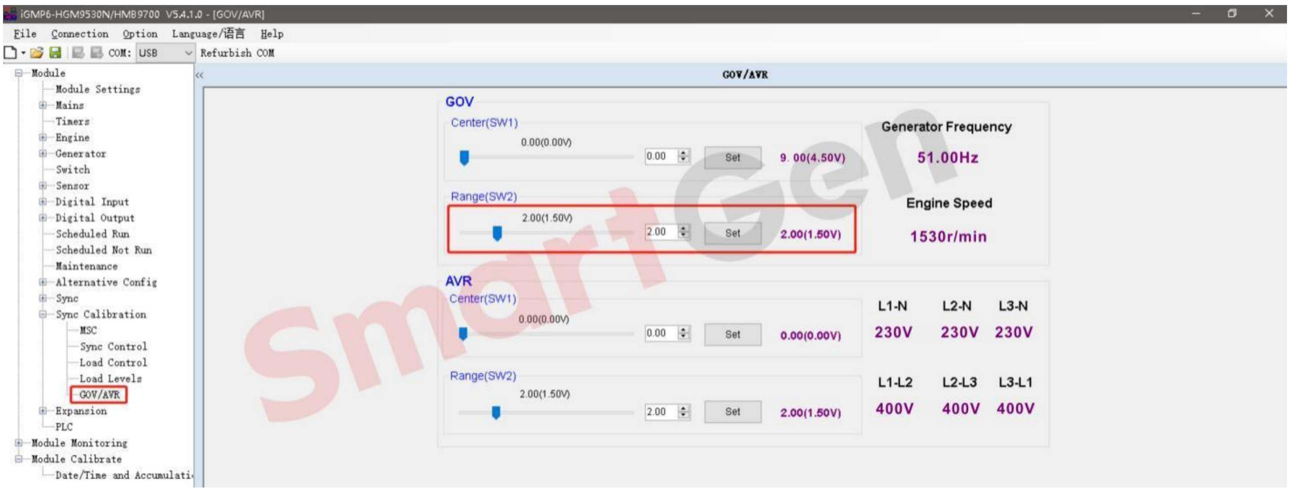


Fig.76 Adjust SW2 of GOV at rated frequency of 51HZ

Reduce the frequency by 1Hz, change it to 49Hz and write it to the controller.

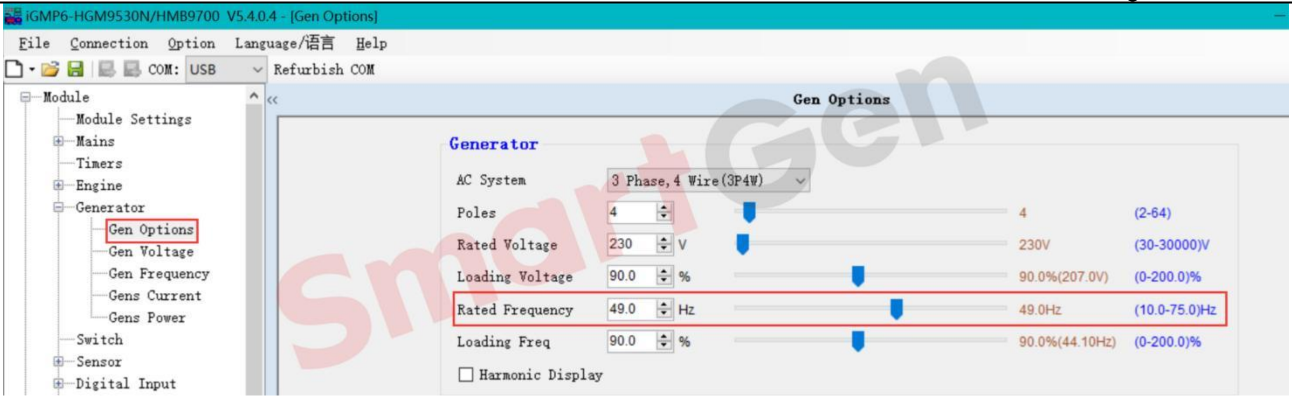


Fig.77 Set the rated frequency to 49HZ

Press the closing button, the generator switch is closed, the frequency slowly drops to 49HZ, and the GOV output percentage at this time should be -29.8%.

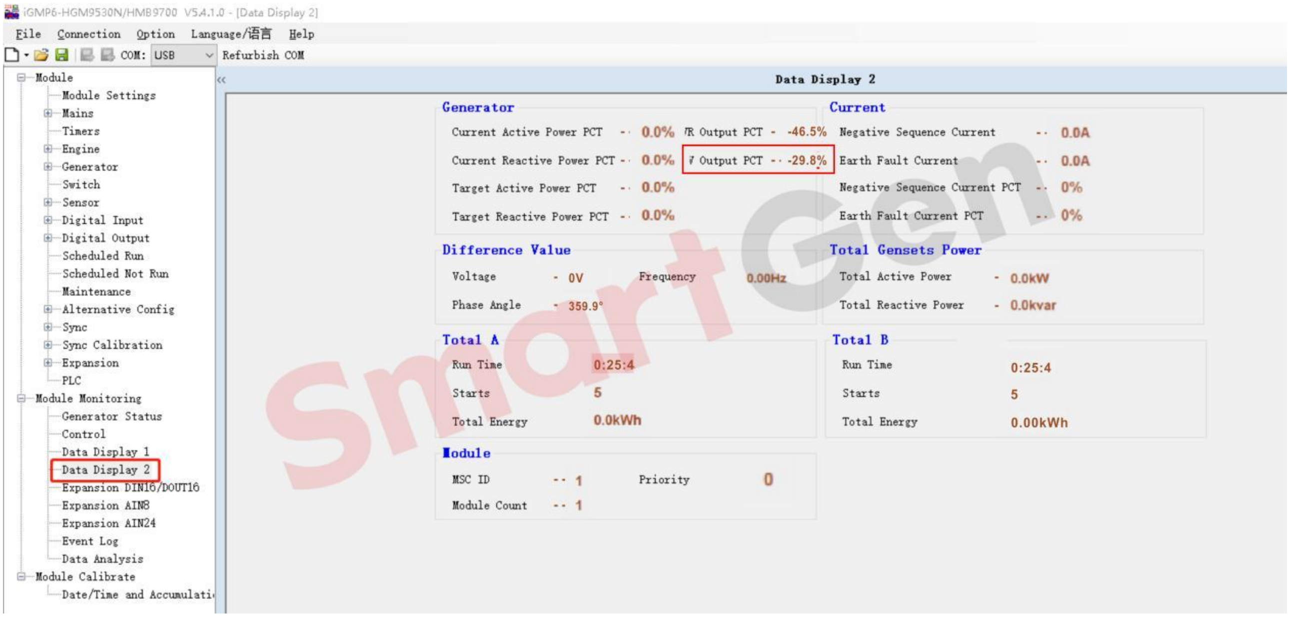


Fig.78 GOV output percentage at rated frequency 49HZ

If the GOV output percentage is not -29.8%, adjust the value of SW2 until the GOV output percentage reaches -29.8% corresponding to the speed of 1470rpm, then press the opening button, the generator switch is open, and press the stop button to stop the unit.

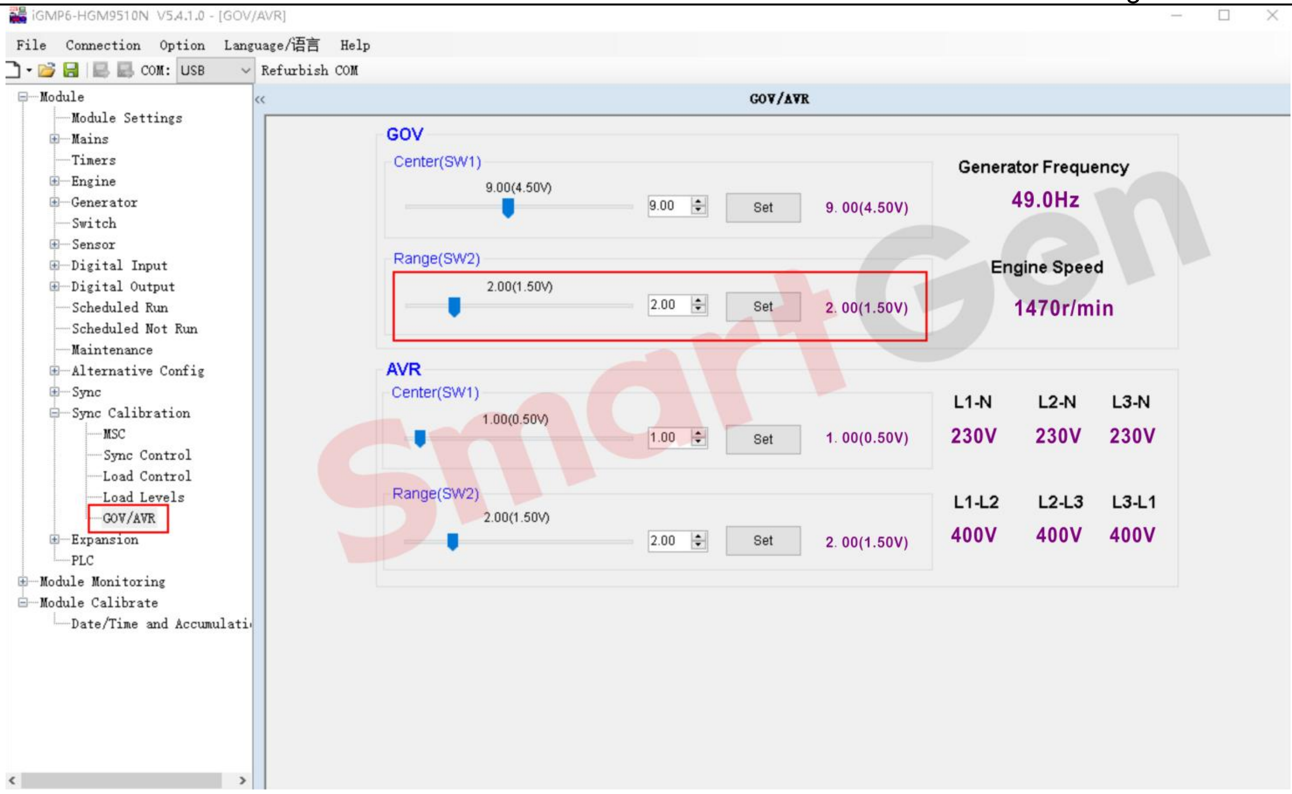


Fig.79 Adjust SW2 of GOV when the rated frequency is 49HZ

After completing the above steps to adjust the engine speed (frequency), it is necessary to rewrite the rated frequency into the controller.

Precautions for adjusting engine speed (frequency):

——After the frequency is adjusted to 51Hz, if the engine itself is stable, there is no need to adjust the gain and stability of frequency synchronous voltage control under the synchronization control (as appropriate).

——After the frequency is adjusted to 49Hz, if the engine itself is stable, there is no need to adjust the gain and stability of frequency synchronous voltage control under the synchronization control (as appropriate).

——After the adjustment is completed, the rated frequency needs to be rewritten into the controller.

3.3.2.2 Voltage Regulation Control

Take the SX440 AVR as an example, wire and set the values of SW1 and SW2.

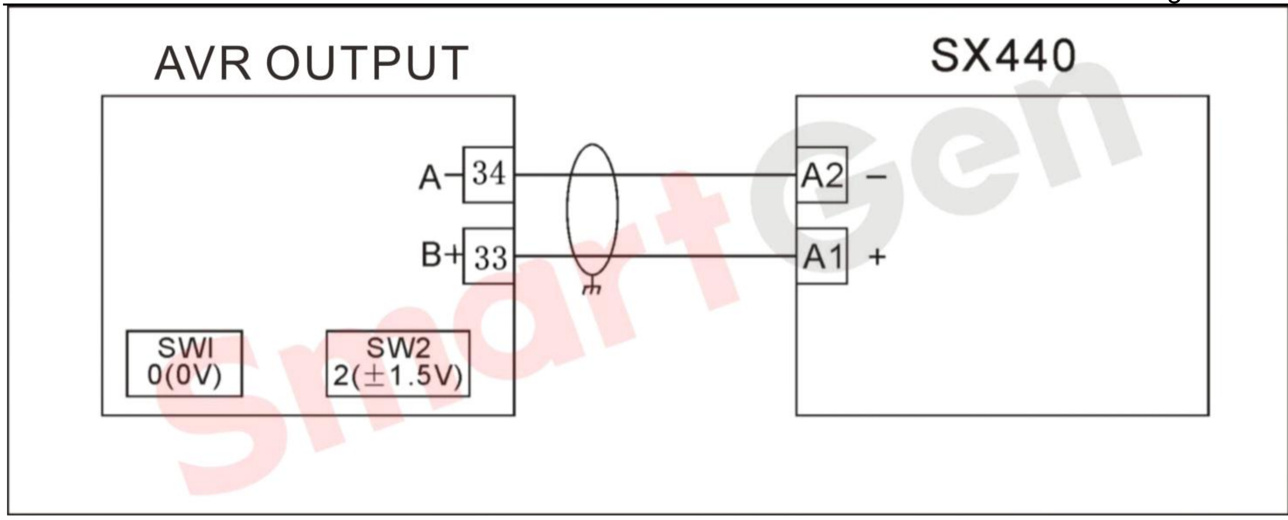


Fig.80

AVR Parameter setting and wiring diagram

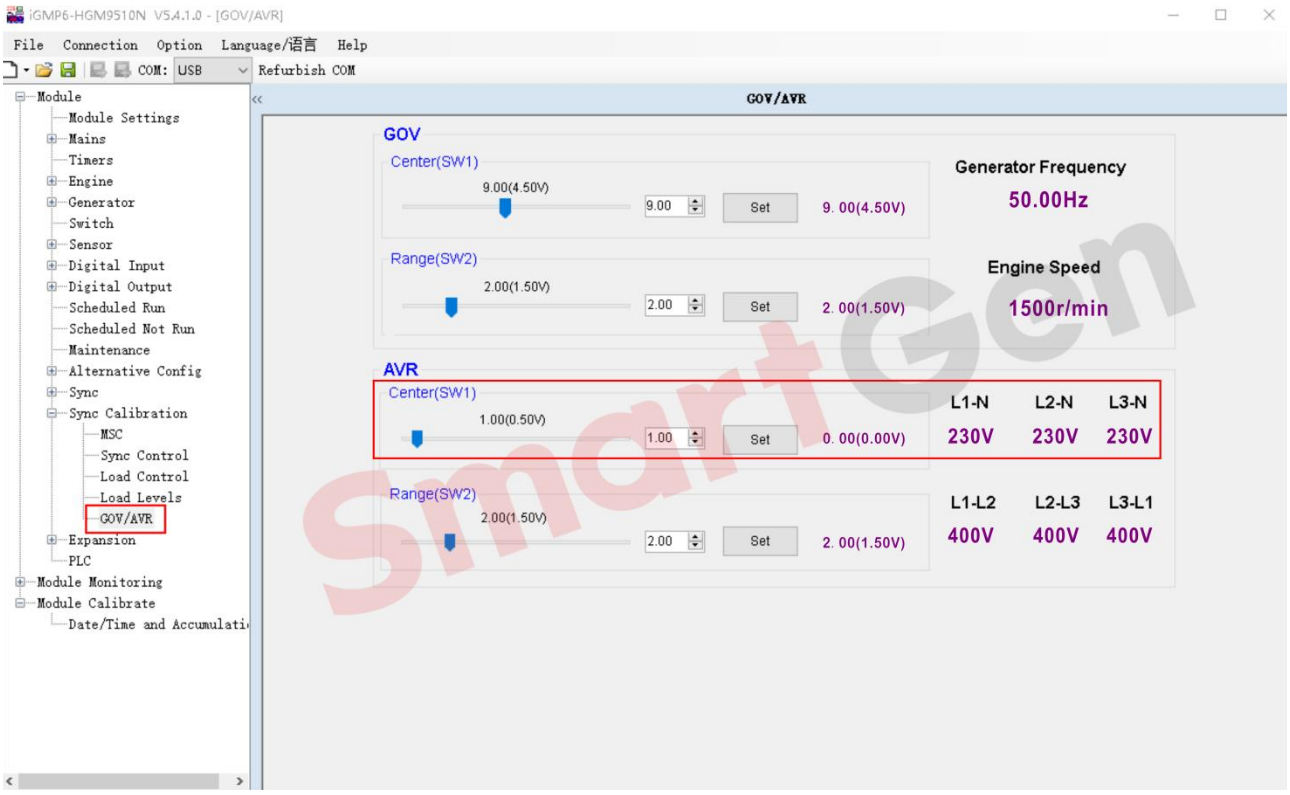


Fig.81 Adjust SW1 of AVR

Adjusting the SW1 of AVR has two purposes, one is to judge whether the AVR board itself is normal; the other is to judge whether the wiring between the controller and the AVR board is correct.

——If the SW1 value is increased, the voltage increases; turn down the SW1 value, the voltage decreases accordingly. This indicates that the wiring is correct.

——If the SW1 value is increased, the voltage decreases instead; turn down the SW1 value, the voltage increases. This indicates that the wiring between the controller and AVR board is wrong.

Solutions to wiring errors:

——Change the position of the two AVR wires.

——Select Output Reverse.

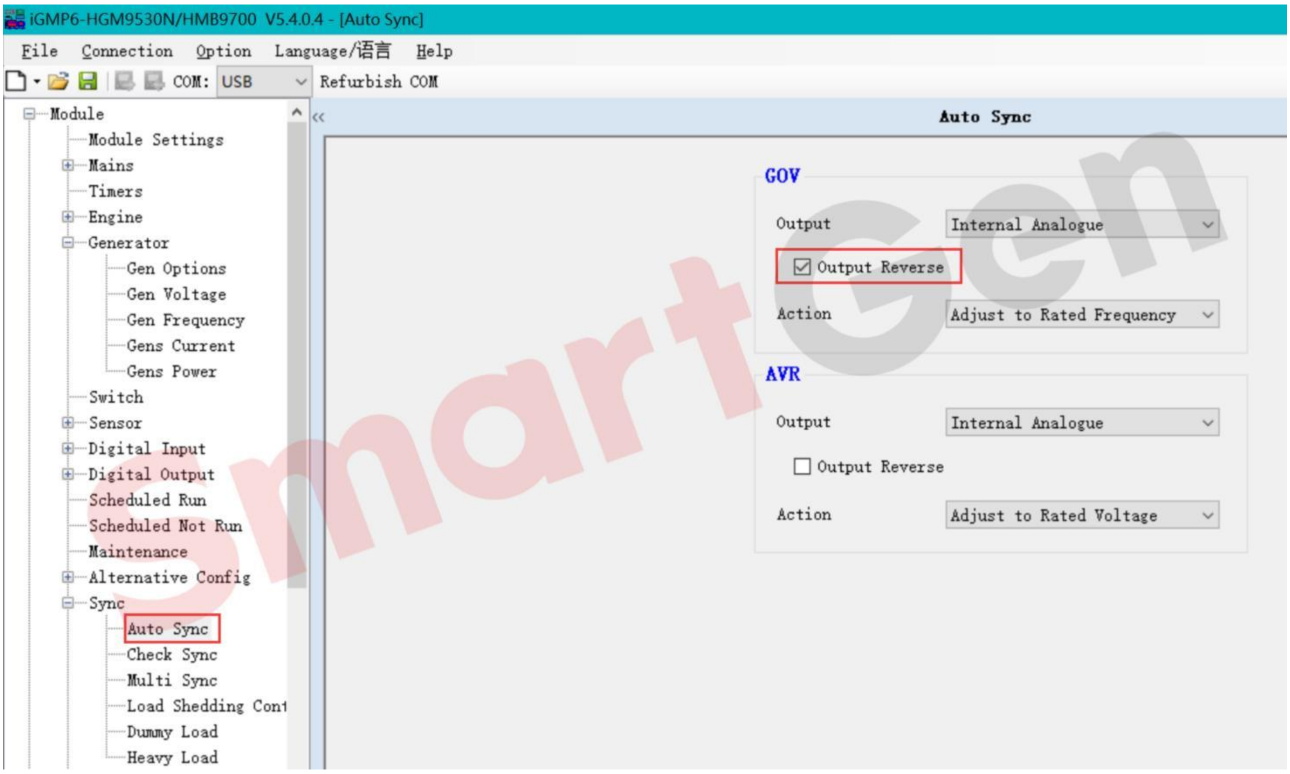


Fig.82 AVR Output Reverse Enable

The adjustment range of the voltage is between ±10V, the purpose is to make the adjustment range of the voltage relatively wide when the controller finds the synchronization point (applicable to different generators in parallel).

First increase the voltage by +10V, adjust it to 240V, and write it into the controller.

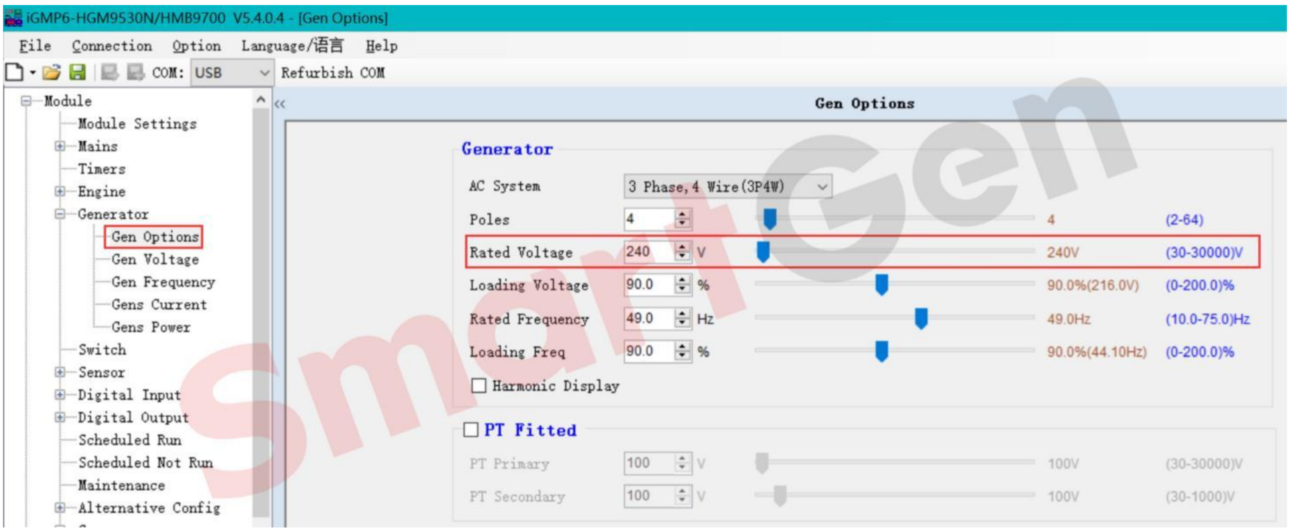


Fig.83 Adjust the rated voltage of generator to 240V

The controller is turned on in manual mode. After the unit is running normally, press the closing button, the generator switch is closed, and the generator voltage slowly rises to 240V. At this time, the AVR output percentage is 43.8%.

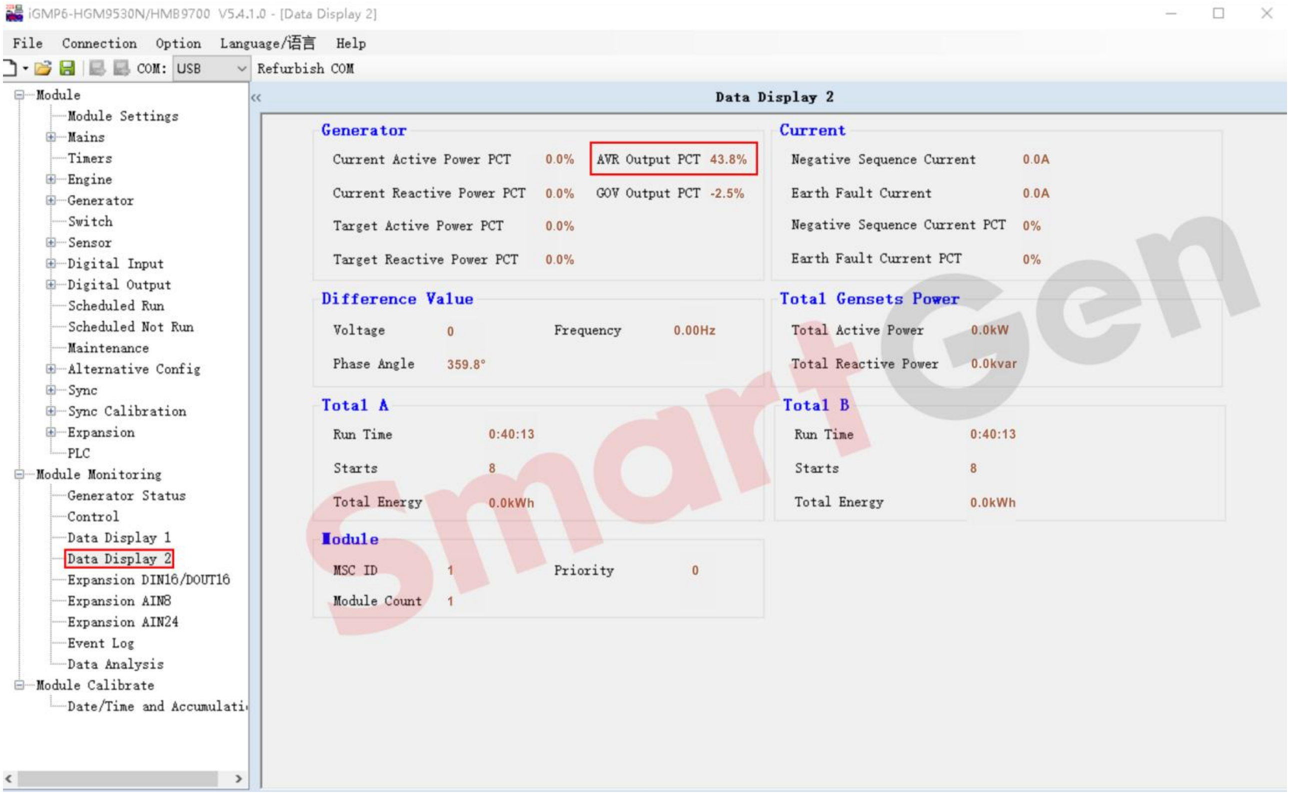


Fig.84 AVR output percentage at rated voltage of 240V

If the AVR output percentage is not 43.8%, increase or decrease the value of SW2 until the AVR output percentage is adjusted to 43.8% corresponding to 416V, press the opening button to open the power generation switch.

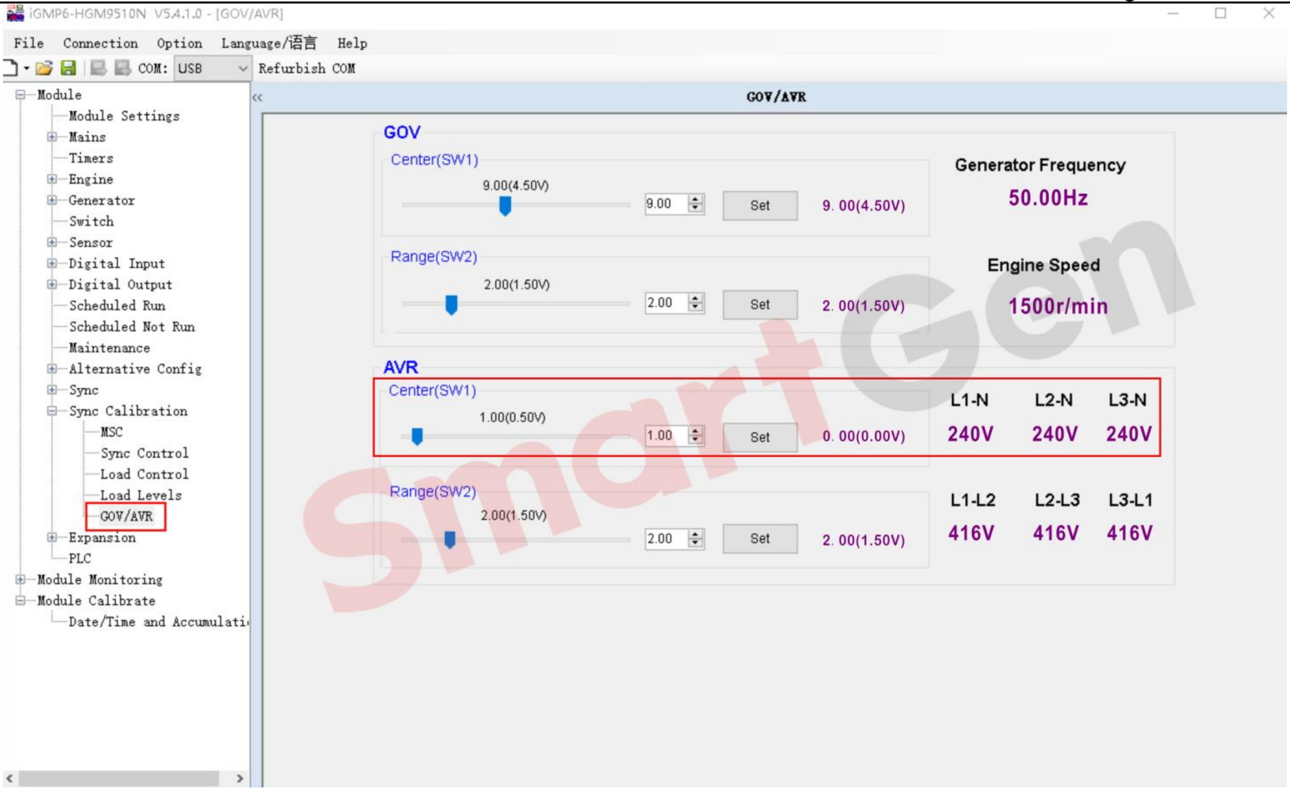


Fig.85 SW1 of AVR at rated voltage of 240V

Reduce the voltage by -10V, adjust it to 220V, and write it into the controller.

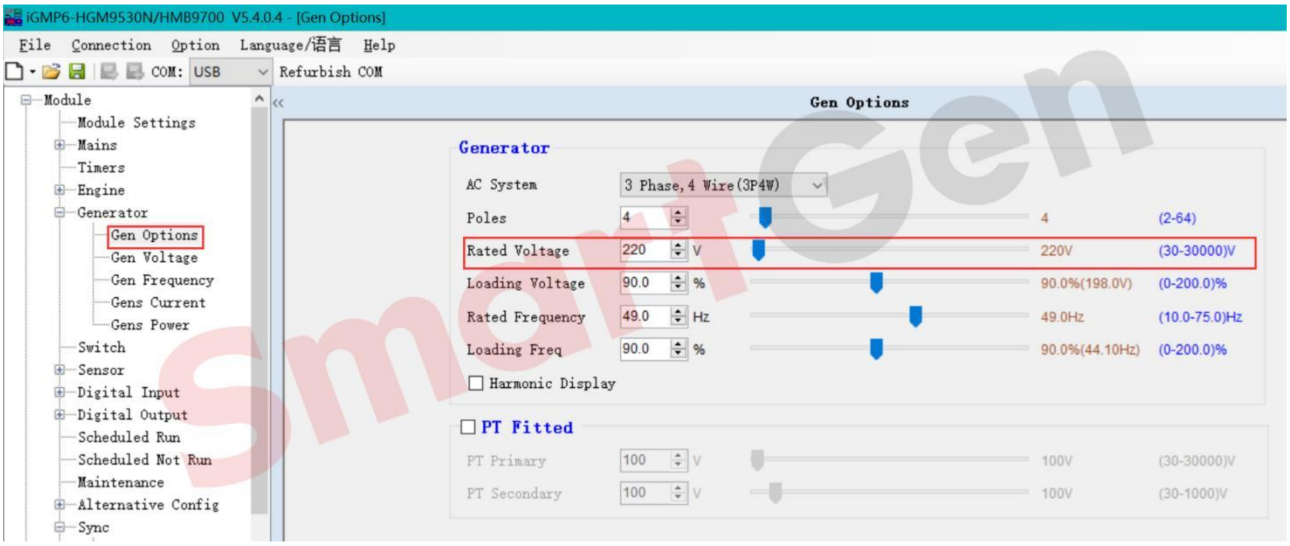


Fig.86 Set the rated voltage of generator to 220V

The controller is turned on in manual mode. After the unit is running normally, press the closing button, the generator switch is closed, and the generator voltage slowly drops to 220V. At this time, the AVR output percentage should be -84.7%.

Fig.87 AVR output percentage at rated voltage of 220V

If the AVR output percentage is not -84.7%, increase or decrease the value of SW2 until the AVR output percentage is adjusted to -84.7% corresponding to a voltage of 380V, press the opening button to open the generator switch, and then press the stop button to stop the unit.

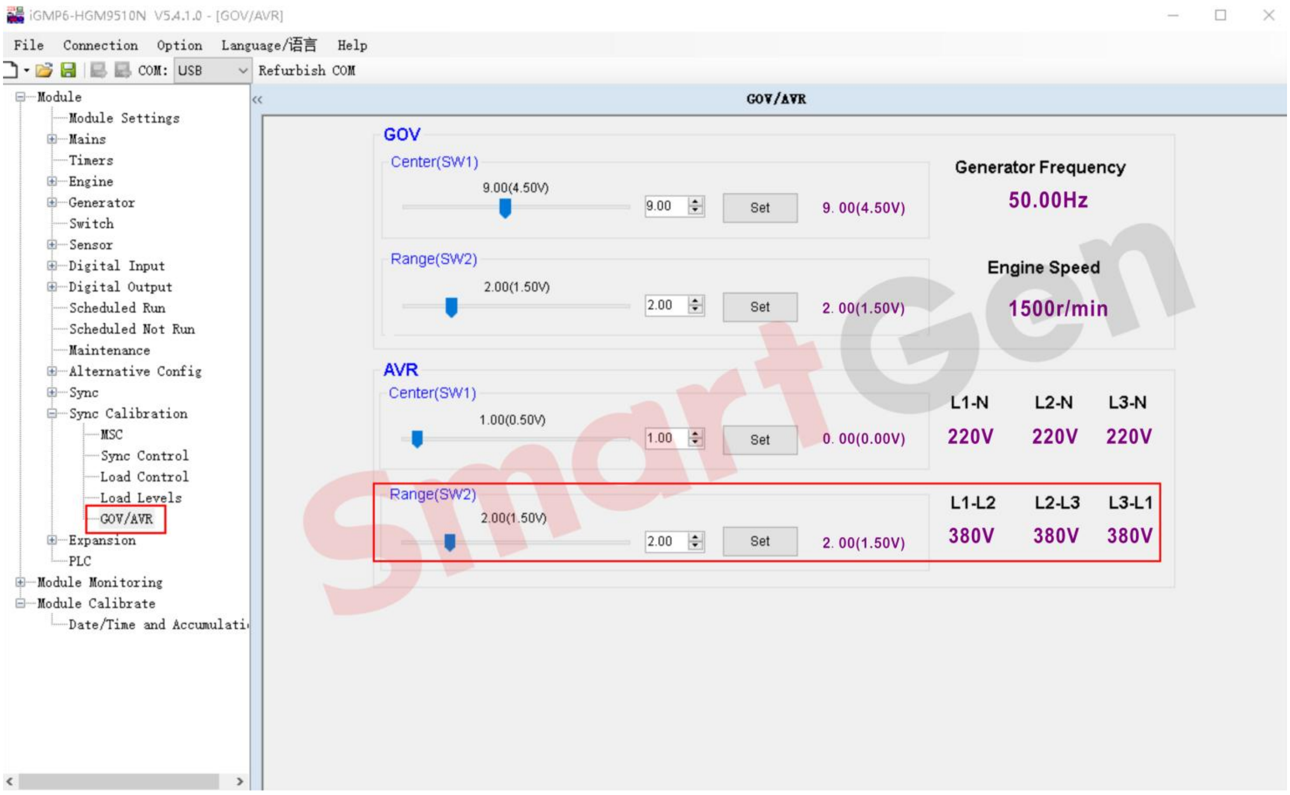


Fig.88 SW2 of AVR at rated voltage of 220V

After completing the above steps to adjust the engine voltage, it is necessary to rewrite the rated voltage into the controller.

Precautions for adjusting generation voltage:

——After the generation voltage is adjusted to 240V, if the engine itself is stable, there is no need to adjust the gain and stability of voltage control under synchronous control (as appropriate).

——After the generation voltage is adjusted to 220V, if the engine itself is stable, there is no need to adjust the gain and stability of voltage control under synchronous control (as appropriate).

3.3.3 Step 2: Inspect the Installation Position and the Wiring of Current Transformer

Inspection purpose: To avoid incorrect wiring of S1 and S2 on the current transformer, resulting in inaccurate load distribution by the controller, to avoid reverse current direction, negative current and negative power.

Inspection steps: First check whether the installation position and direction of the current transformer is correct (the correct direction is P1 to P2, and the power generation to the load); then check whether the wiring

of the current transformer is correct (in the correct wiring, S1 of the three current transformers are connected to IA, IB, IC respectively, and S2 is connected to the common terminal Icom for grounding).

Detection method: After the unit is turned on, take a little load, and judge the direction of the current.

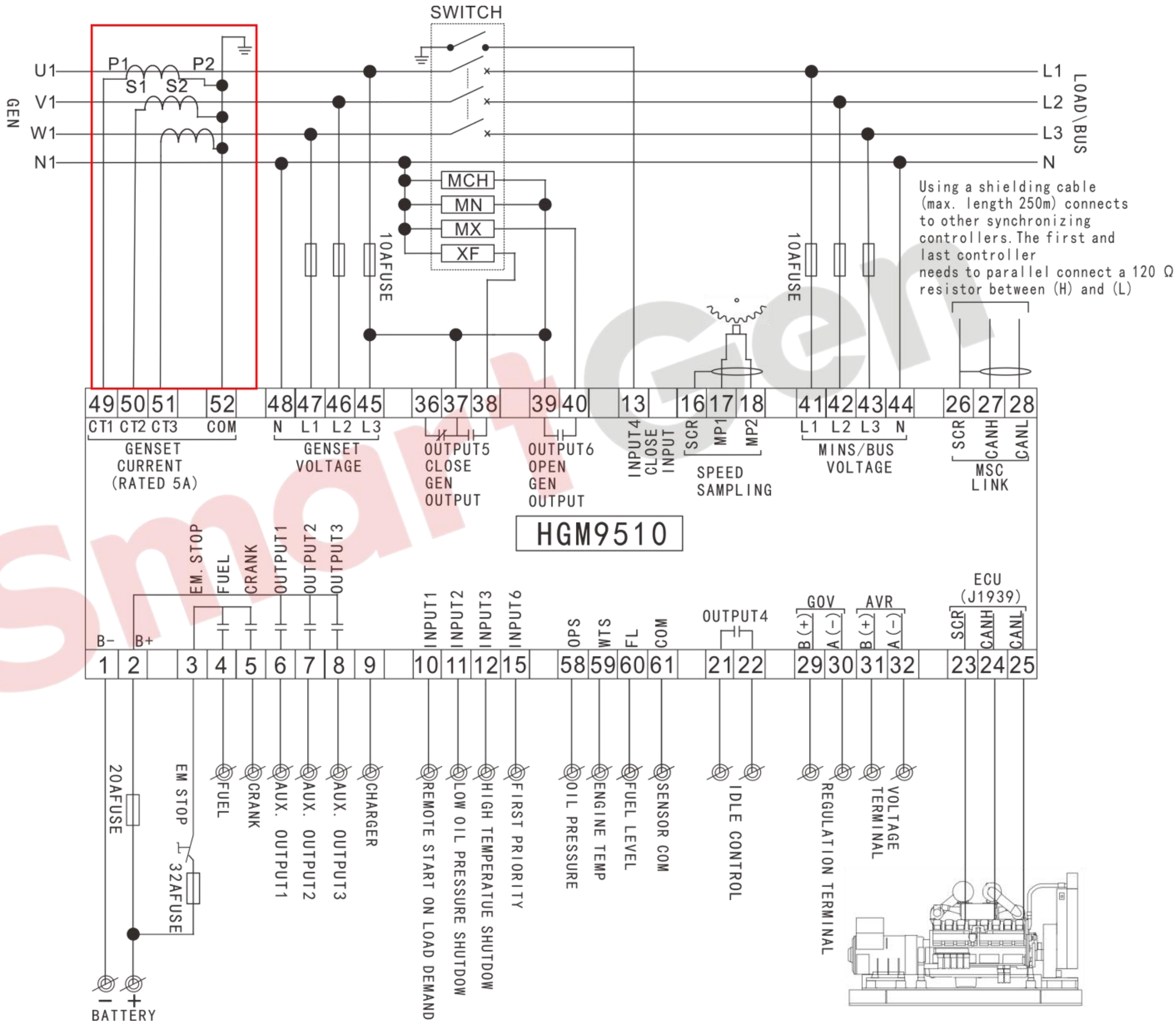


Fig. 89 Position and wiring of current transformer

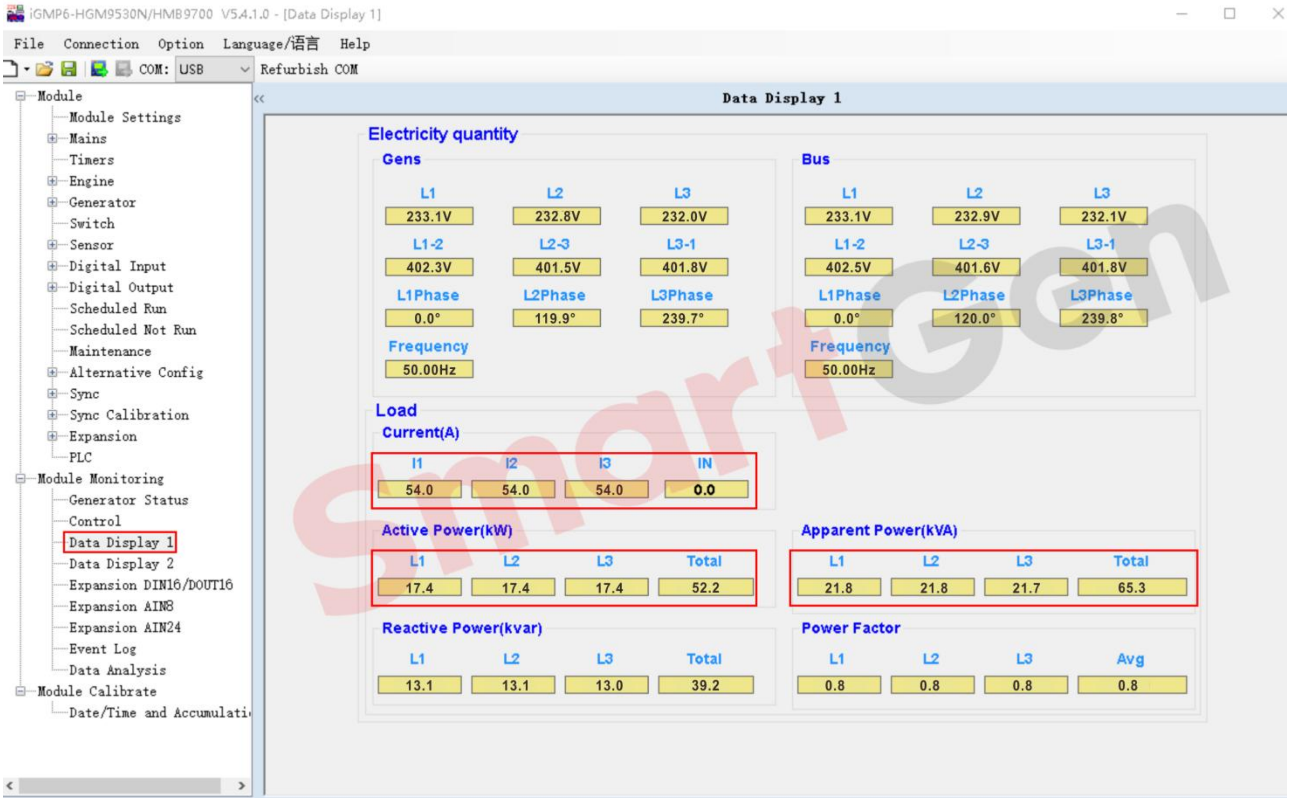


Fig. 90 Current and power display of correct current transformer installation

If the wiring is wrong, the following phenomena may occur.

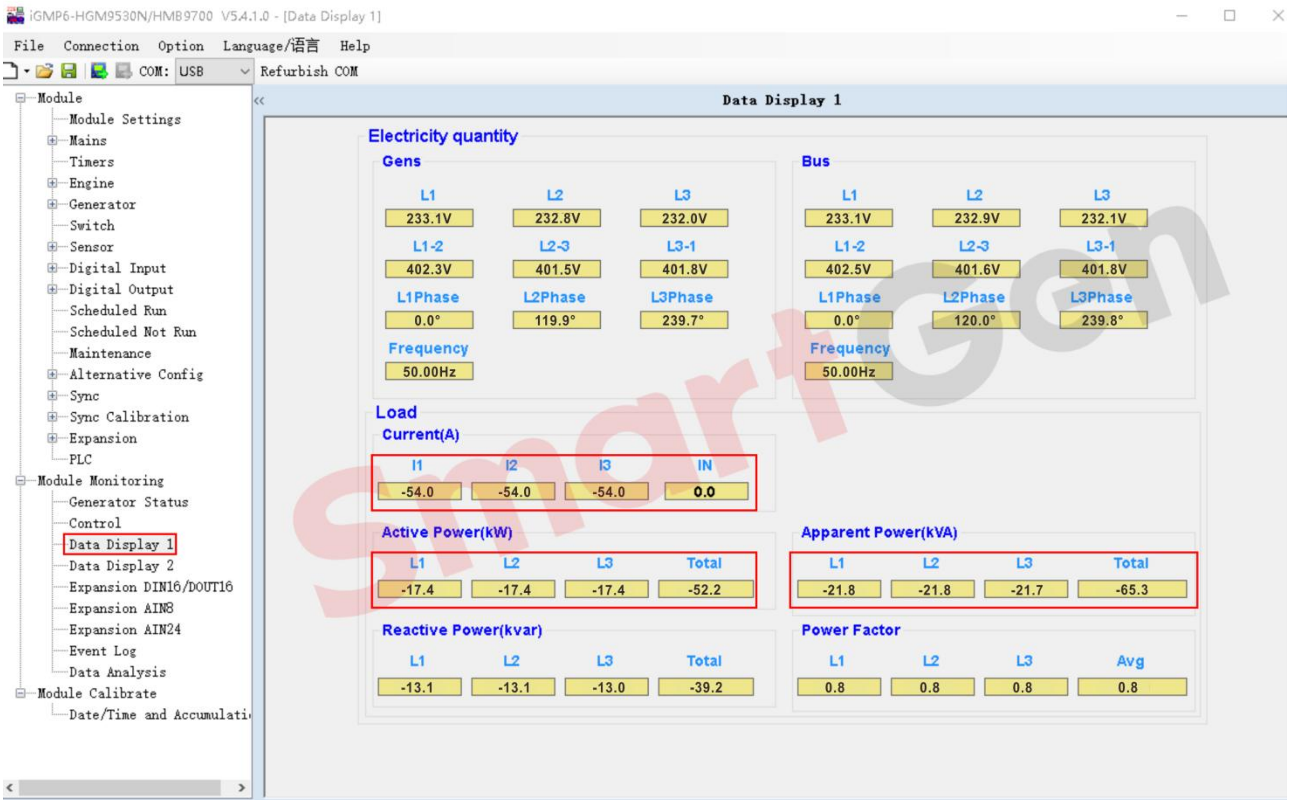


Fig. 91 Current and power display negative values of incorrect current transformer installation

The wrong wiring of L1, L2 and L3 phase current transformers will cause the active power value and the apparent power value to display negative values. Therefore, the correct installation position and wiring of the current transformers are very important for the units to be loaded in parallel, otherwise the reverse power trip warning will appear.

3.3.4 Step 3: Check MSC Communication between Multiple Units

3.3.4.1 Description

3.3.4.1.1 Set the ID number of each unit correctly and cannot be repeated ((avoid alarm)); Set the correct ID number. If there is a module ID error alarm, after modifying the conflicting ID address, long press the stop button to eliminate the alarm.

3.3.4.1.2 Check whether a 120ohm resistor is connected between the MSC communication ports H and L of the first controller; check whether a 120ohm resistor is connected between the MSC communication ports H and L of the last controller.

3.3.4.2 Setting Module Running Priority Can Realize Two Functions

3.3.4.2.1 If the module running priority is set to the same number, all units will start when the unit is in the Auto position.

3.3.4.2.2 If the module running priority is set to the same number as the respective ID, the unit with the smallest number will have the highest priority, and the unit with the highest priority will start up and load first. When the load power is greater than the power setting value when the unit is scheduled to start up, the unit with the second highest priority starts up and loads in parallel with the bus, and so on.

Fig. 92 Set module ID and priority

3.3.4.3 Set as Main Selection through the Aux. Input

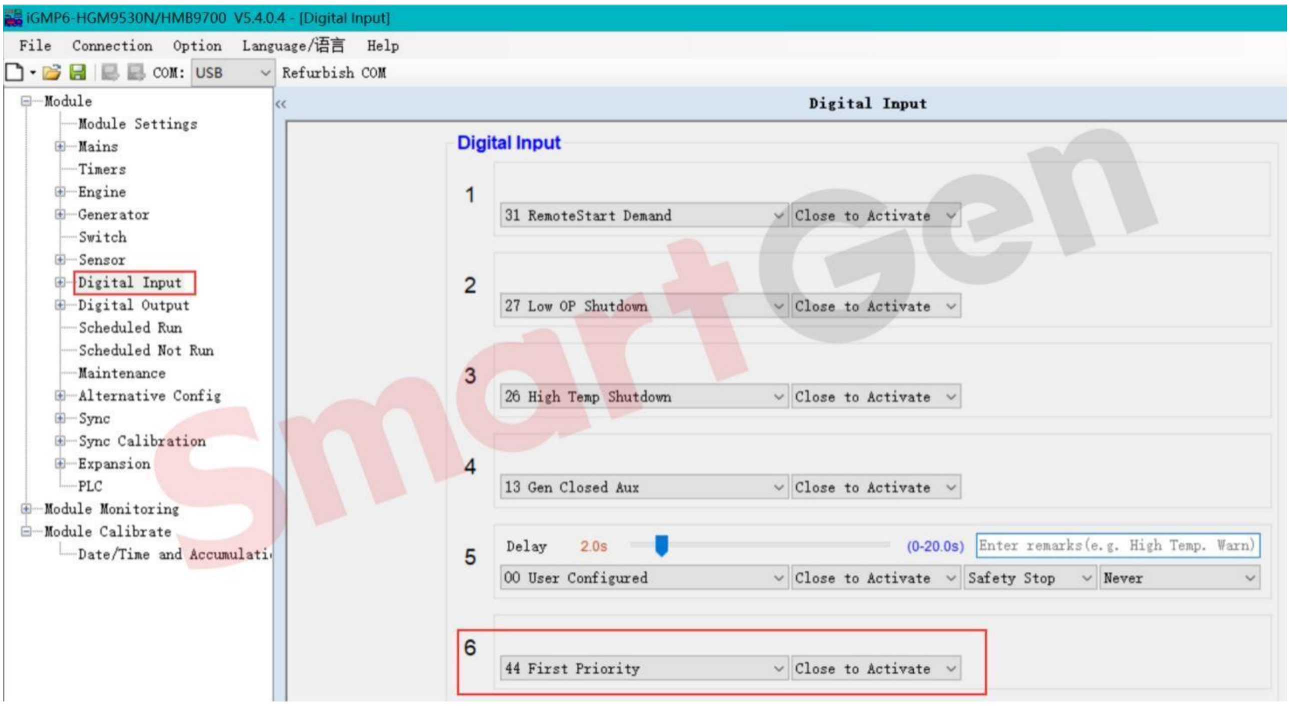


Fig.93 First Priority setting

3.3.5 Step 4: Sync Check

3.3.5.1 Check Wiring

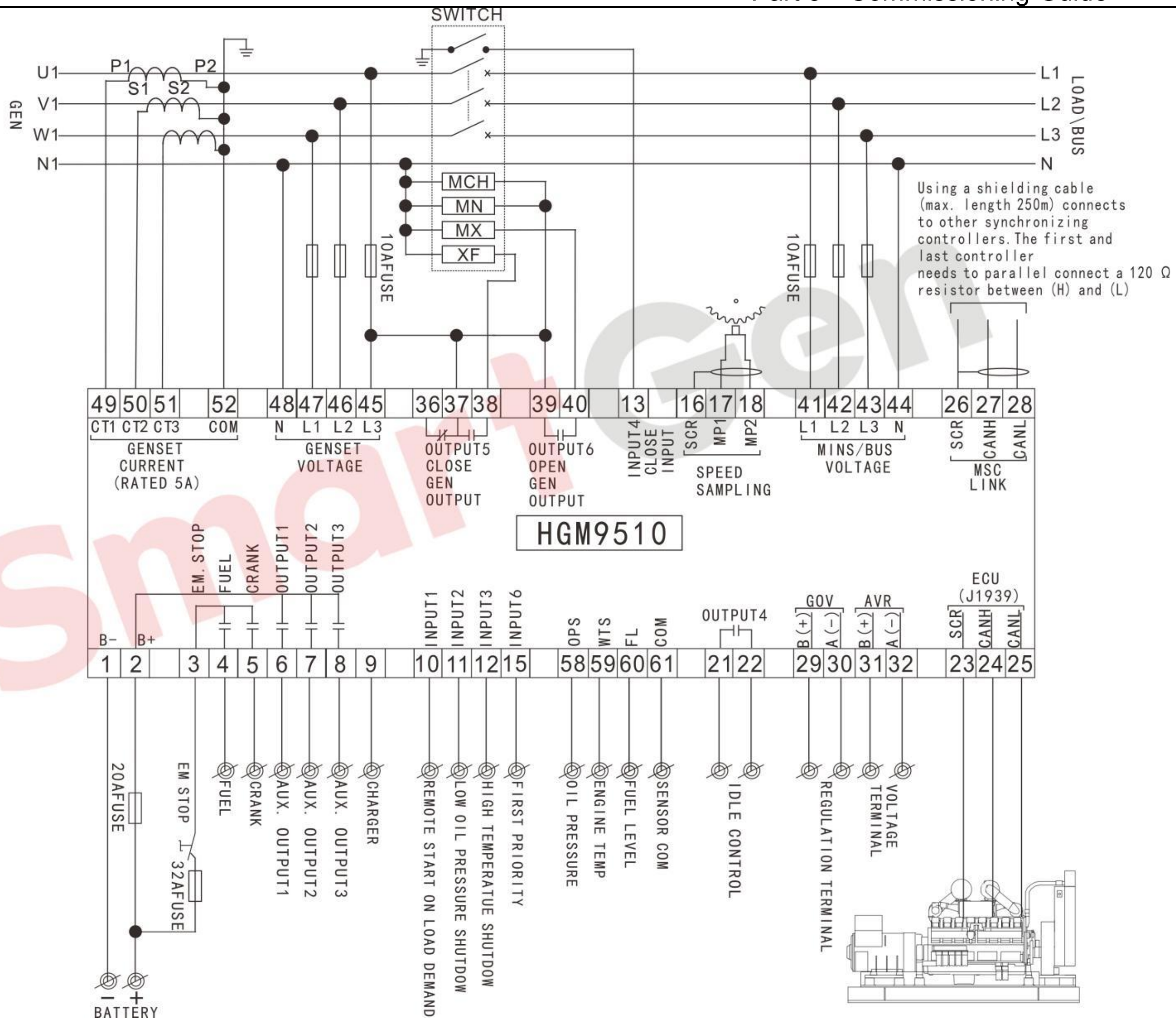


Fig.94 Correct wiring of Gens cables

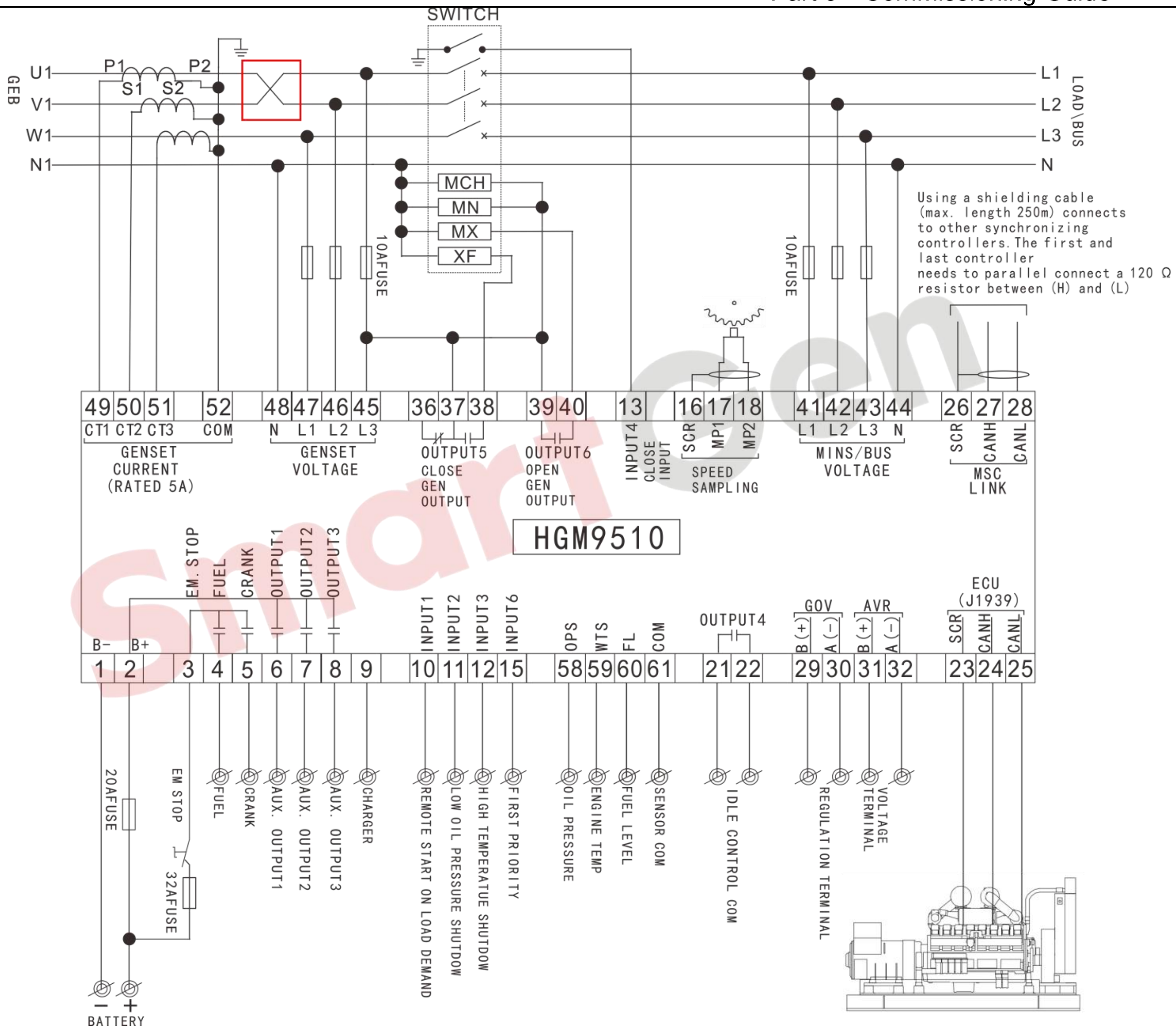


Fig.95 Wrong wiring of Gens cables

3.3.5.2 Check Phase Sequences

Before paralleling, check whether the phase sequence of the single unit and the busbar is consistent; if it is inconsistent, the paralleling may not be successful and may even be dangerous. The correct phase sequence is 0°-120°-240°.

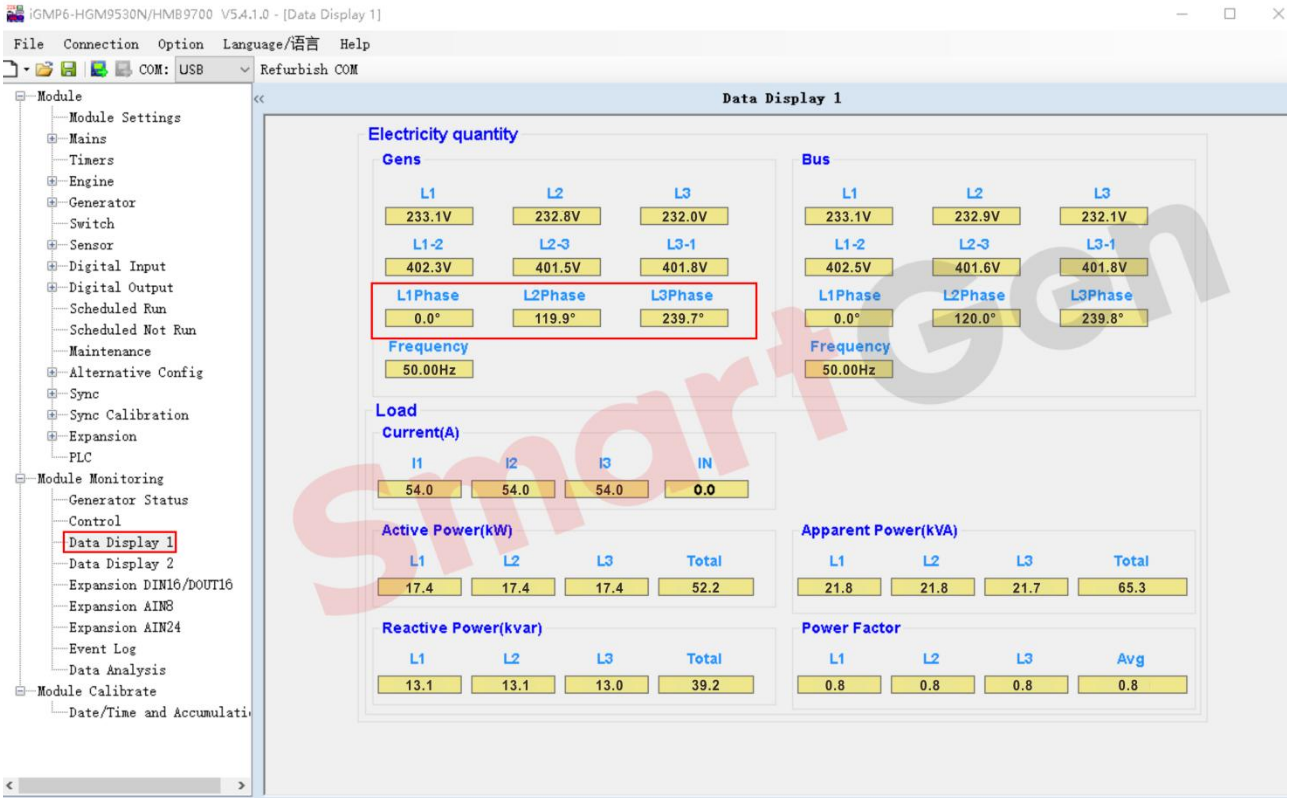


Fig.96 Correct phase sequence display

The wrong phase sequence is 0°-240°-120°. If the phase sequence is connected incorrectly, the unit will send out a phase sequence error alarm and shutdown after starting up to establish the generating voltage.

Fig.97 Gens phase sequence error shutdown alarm

3.3.5.3 Phase Sequence Inspection Method for Parallel Connection between Generators or Parallel Connection between Generator and Mains

When the generator sets are connected in parallel, start one unit first, check whether the generation phase sequence on the controller is 0° - 120° - 240° after the power generation is normal. In case of power generation phase sequence error alarm and shutdown, check whether the generation cable and generation voltage sampling line are connected reversely. After the generation phase sequence is correct, close the generation switch and observe whether the bus phase sequence is correct. If the voltage bus phase sequence error alarm and shutdown, check whether the output end of the power generation switch is connected reversely to the bus cable and the bus voltage sampling line. Start another unit in parallel with the busbar synchronously. If there is a voltage bus error alarm and shutdown after synchronous closing, check whether the power generation cable and power generation voltage sampling line of the unit or the cable from the switch output end to the busbar and the busbar voltage sampling line are connected reversely.

When the generator and the mains are connected in parallel, check whether the phase sequence of the mains on the controller is 0°-120°-240°. If there is a warning of the reverse phase sequence of the mains, check whether the power cable and the mains voltage sampling line are reversed; Start the generator set, check whether the generation phase sequence is 0° - 120° - 240° after the generator runs normally. In case of power generation phase sequence error alarm and shutdown, check whether the generation cable and generation voltage sampling line are connected reversely.After the generation phase sequence is correct, close the generation switch and observe whether the bus phase sequence is correct. If the voltage bus phase sequence error alarm and shutdown, check whether the output end of the power generation switch is connected reversely to the bus cable and the bus voltage sampling line.

Regarding phase sequence detection, it can also be detected by other external auxiliary tools, such as phase sequence meters and multimeters, which can improve the efficiency in the parallel process.

——Phase Sequence Meter Measurement

Fig. 98 Phase sequence meter installation

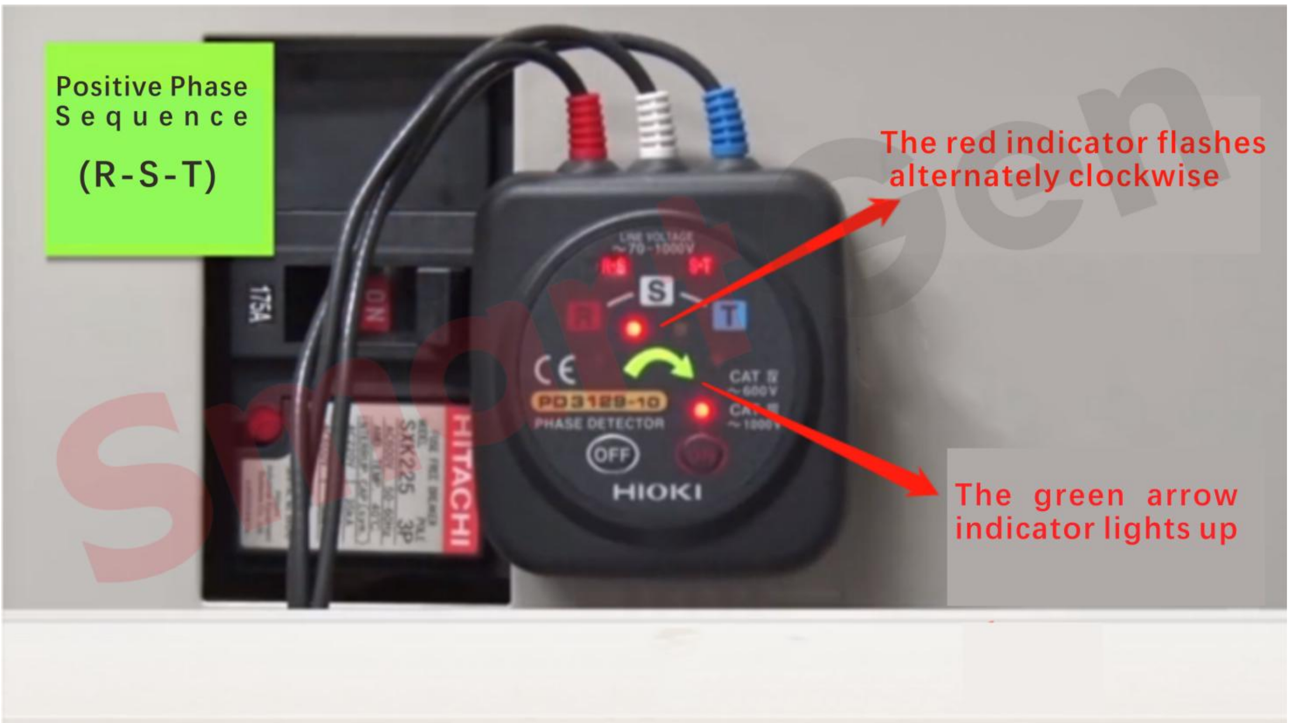


Fig. 99 Correct phase sequence indication

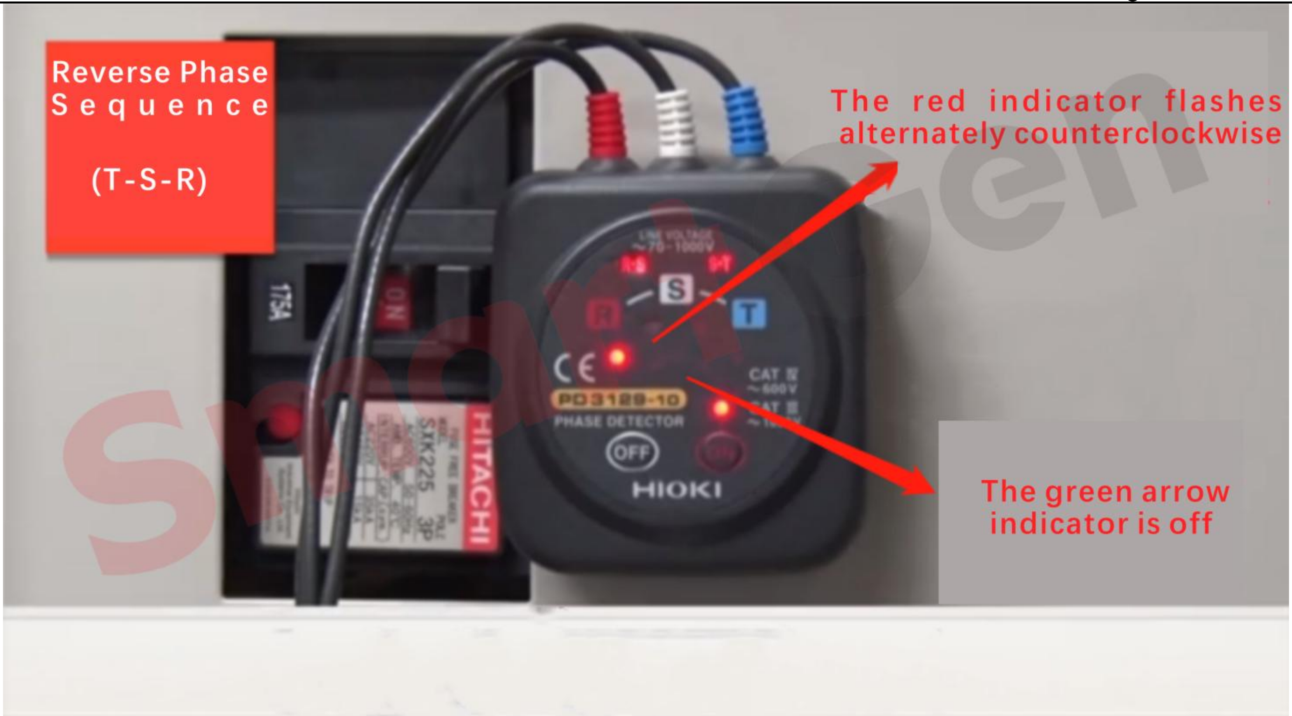


Fig. 100 Wrong phase sequence indication

——Multimeter Measurement

For Low voltage 400V or below, set the multimeter to AC 500V or 750V, first set the three-phase A, B, and C of the power supply side, then use a test lead to set the A phase of the power supply side, and another test lead to measure the three phases A, B and C on the opposite side, three different voltage values will be obtained at this time, but two of the voltage values are high and almost equal, and the other is low. Choose the phase A with the lowest value in the same phase as the phase A on the power side. According to this method, measure the other two phases B and C respectively, and finally measure the phase sequence of the power supply on both sides of 400V under the same voltage. When measuring the phase sequence of the high voltage 10KV and above power supply on both sides, while using the above method to measure, it should be measured on the secondary outgoing line of the voltage transformer on both sides, and the selected voltage range should be AC 500V or 700V. At the same time, it is also necessary to check whether the wiring of the voltage transformers on both sides is correct to prevent accidents in parallel caused by different phases.

3.4 Application Diagram of Two Units in Parallel

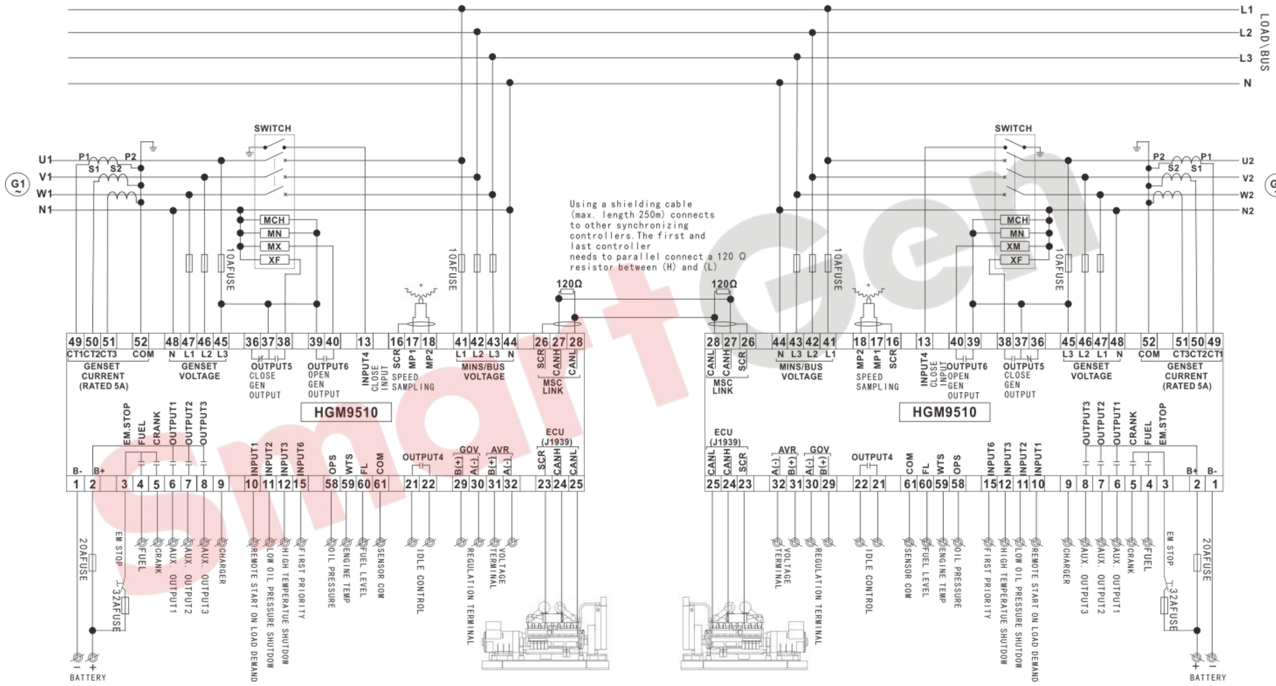


Fig. 101 Unit Parallel Application Diagram

4 GOV/AVR/EFI Engine Setting

4.1 GOV/AVR Control Description

The adjustment of engine speed and generator voltage can be controlled by the DC voltage output of the module. The control voltages of GOV and AVR of different gensets are different, and the GOV and AVR center voltage and range voltage of the parallel controller must be correctly set to match them.

Fig. 102 GOV and AVR setting

4.2 GOV/AVR Parameter Setting

Table 32 GOV and AVR description

Control Interface	Item	Function Description
GOV	Center Voltage (SW1)	Set the GOV speed control center voltage.
	Voltage Range (SW2)	Set the GOV speed control offset voltage range.
	Output Reverse	When the GOV control voltage increases but the engine speed decreases, the Output Reverse needs to be enabled.
AVR	Center Voltage (SW1)	Set the AVR speed control center voltage.
	Voltage Range (SW2)	Set the AVR speed control offset voltage range.
	Output Reverse	When the AVR control voltage increases but the generator voltage decreases, the Output Reverse needs to be enabled.

Table 33 SW1/SW2 Setting value and corresponding control voltage

SW1(Center Voltage)		SW2(Voltage Range)	
Setting Value	Voltage	Setting Value	Voltage
0	0V	0	±0.5V
1	0.5V	1	±1.0V
2	1.0V	2	±1.5V
3	1.5V	3	±2.0V
4	2.0V	4	±2.5V
5	2.5V	5	±3.0V
6	3.0V	6	±3.5V
7	3.5V	7	±4.0V
8	4.0V	8	±4.5V
9	4.5V	9	±5.0V
10	5.0V	10	±5.5V

4.3 HGM9500 Controller GOV/AVR Parameters setting

4.3.1 HGM9500 Controller GOV/AVR Connection Diagram

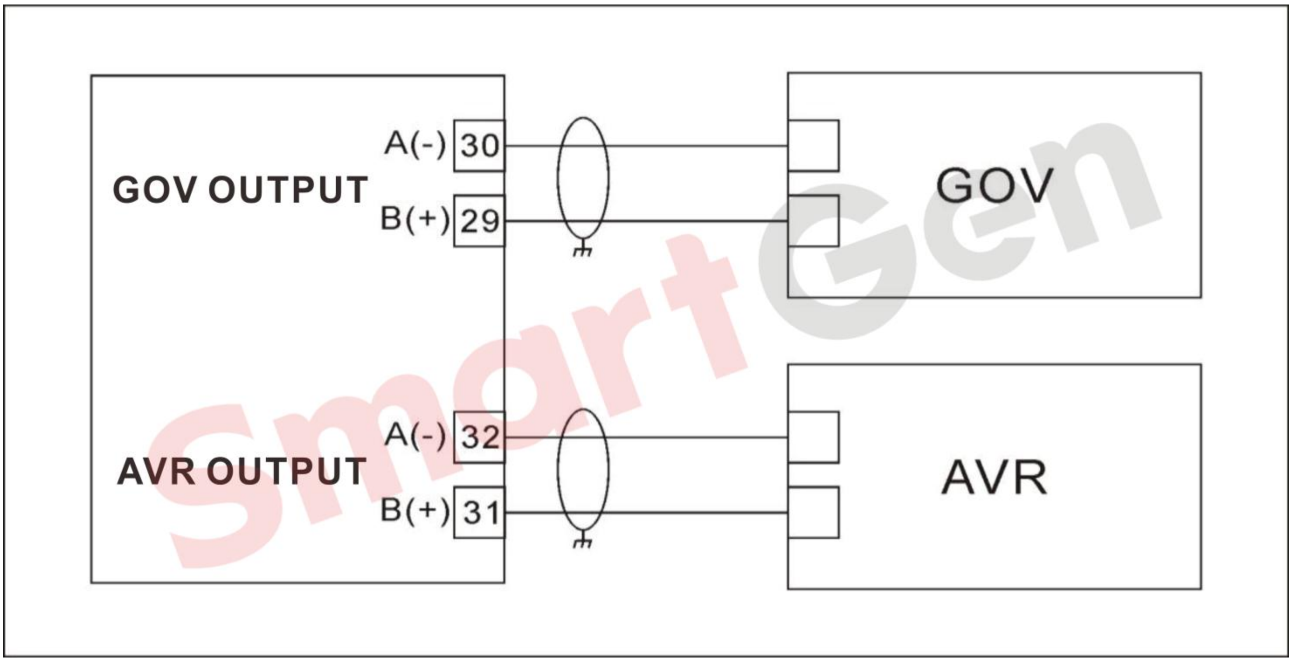


Fig. 103 HGM9500 Controller GOV/AVR Connection diagram

4.3.2 GOV Connection

4.3.2.1 GAC GOV 5100-5500 Series

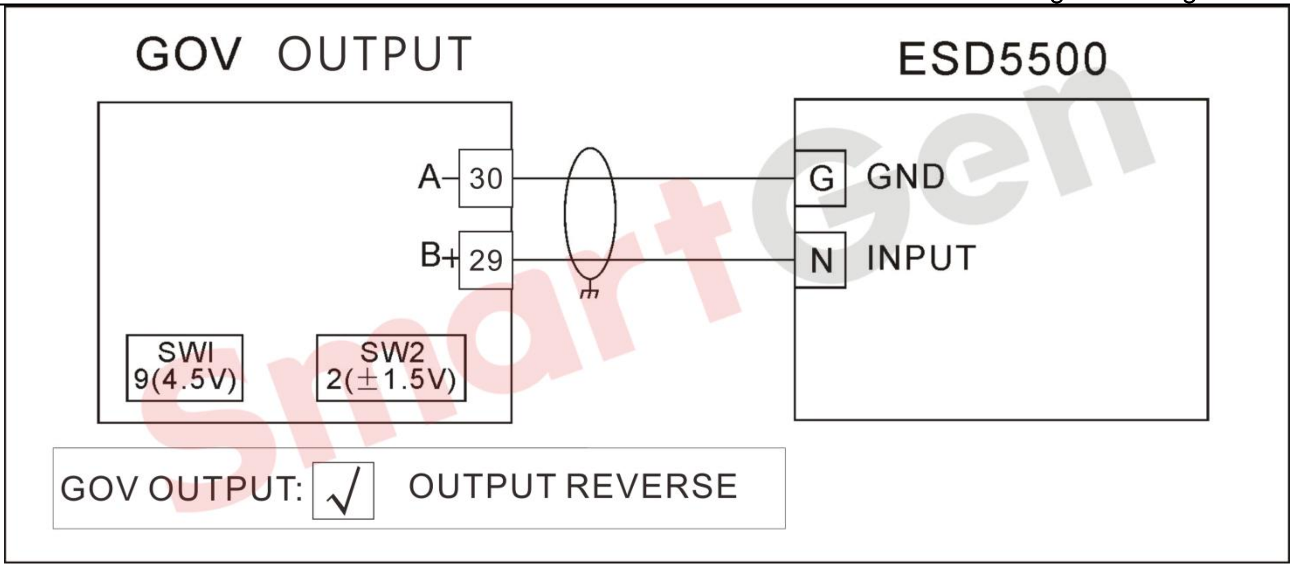


Fig. 104 GAC(5100-5500)

4.3.2.2 CUMMINS

4.3.2.2.1 EFC* Series

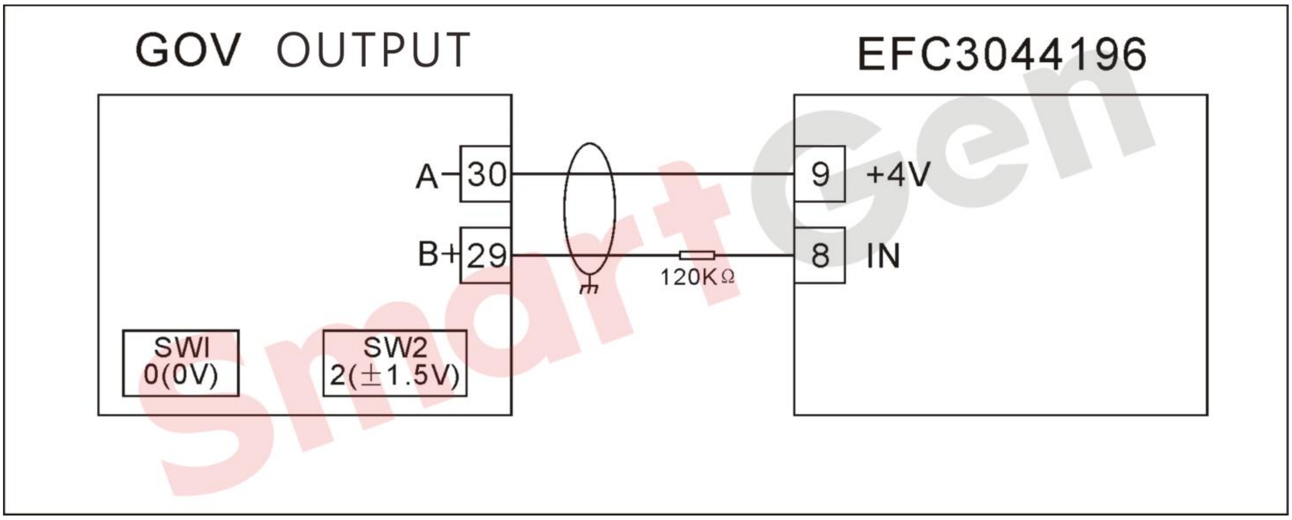


Fig. 105 CUMMINS EFC*Series

4.3.2.2.2 EFCILS

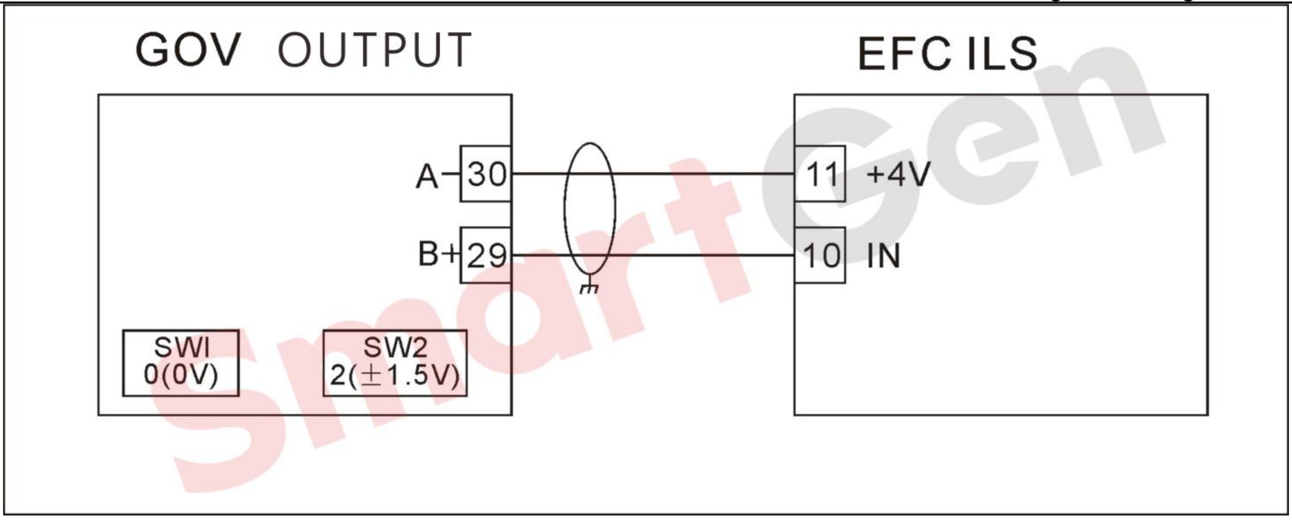


Fig. 106 CUMMINS EFCILS

4.3.2.3 VOLVO

4.3.2.3.1 EMS2

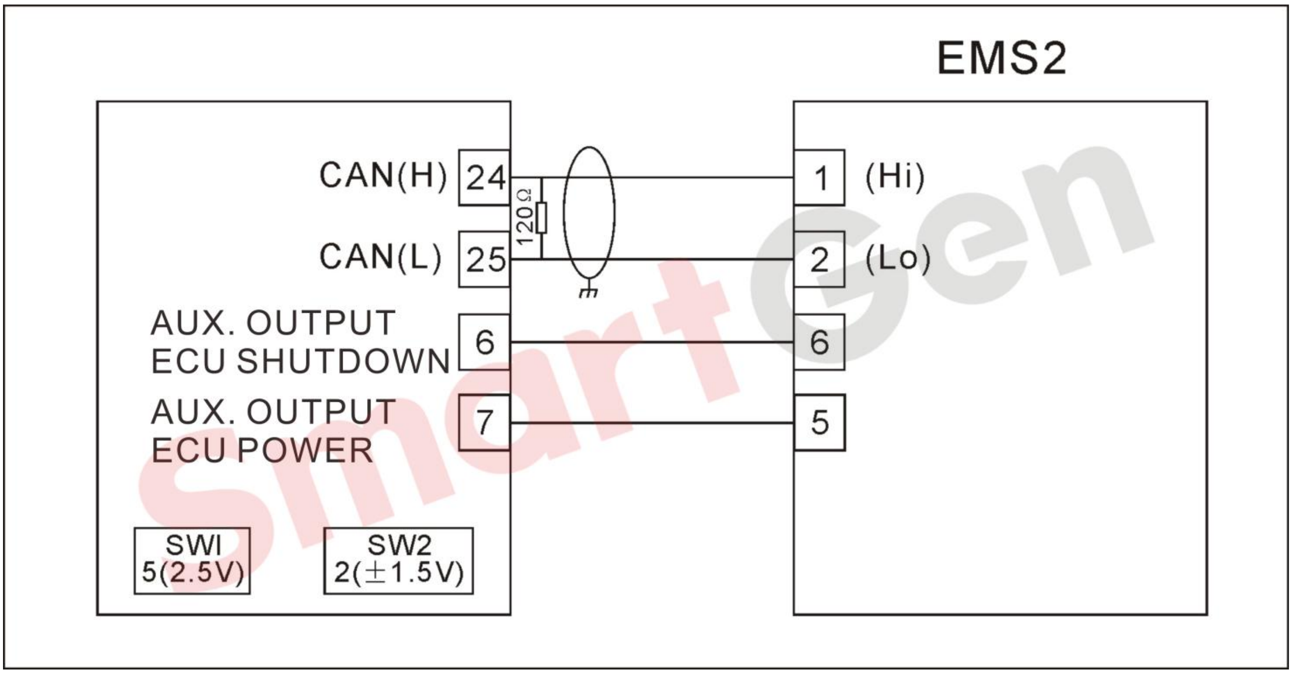


Fig. 107 VOLVO EMS2

4.3.2.3.2 EDC3

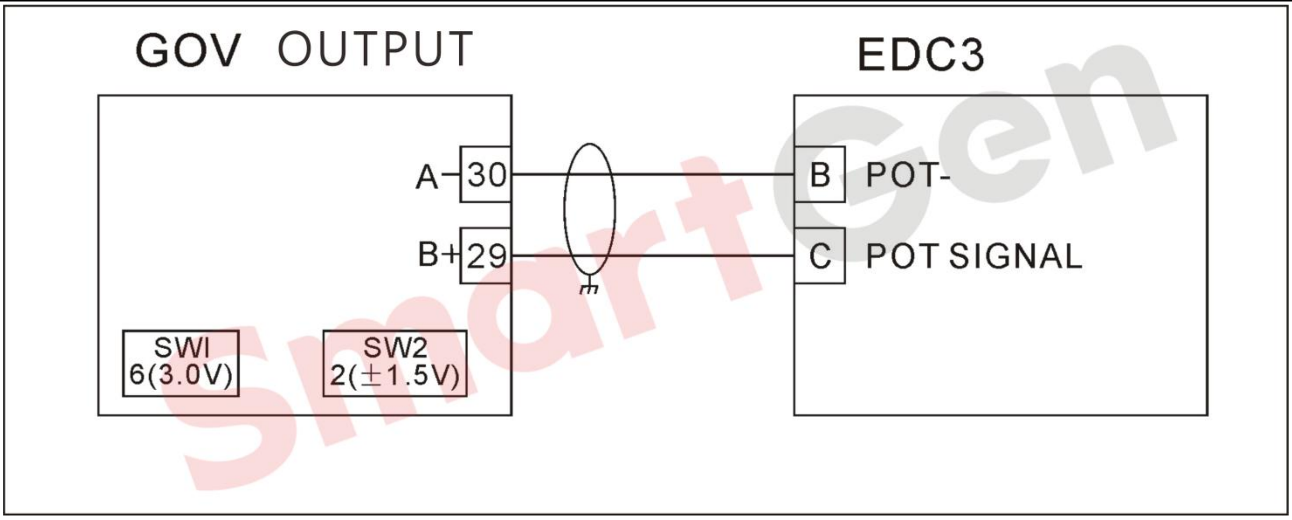


Fig. 108 VOLVO EDC3

4.3.2.4 PERKINS

4.3.2.4.1 2000 Series Engine

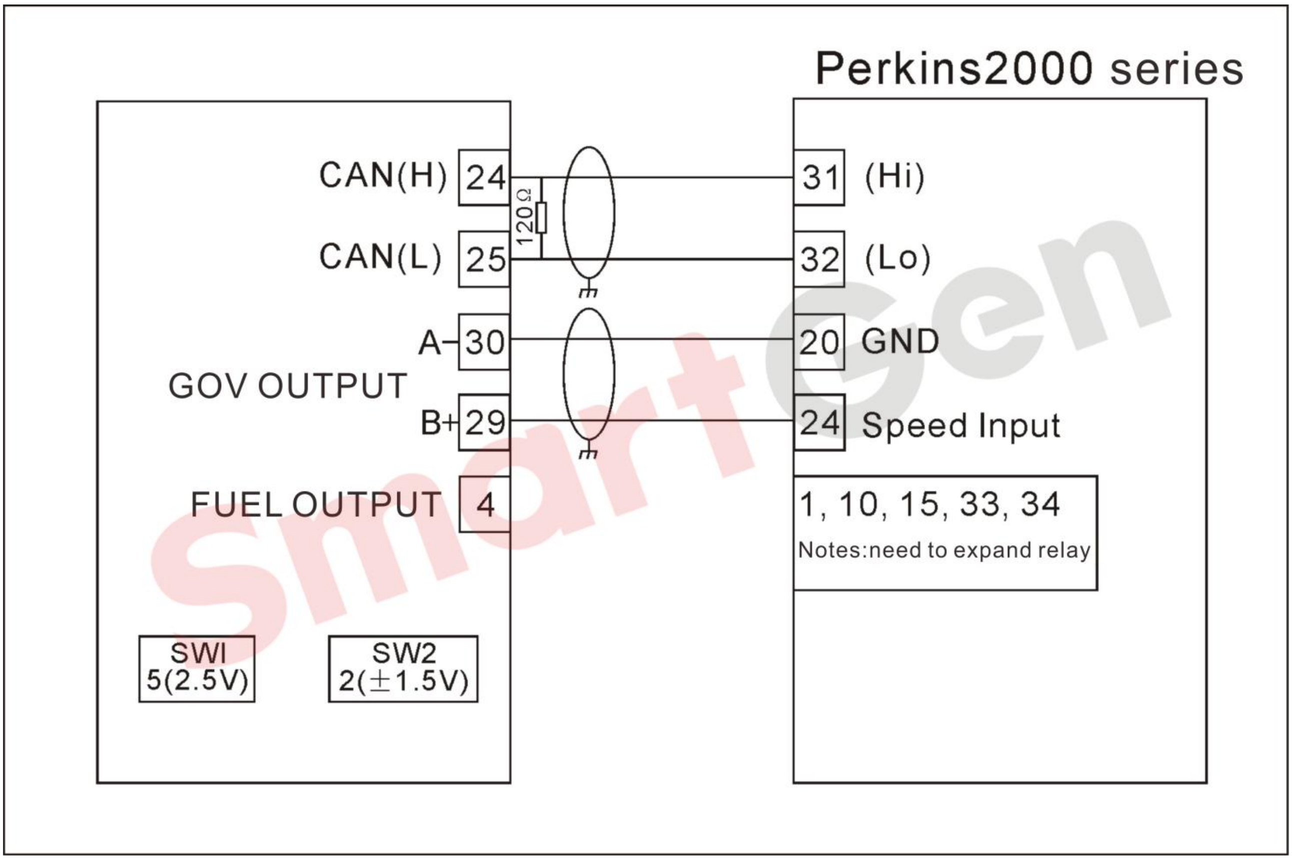


Fig. 109 PERKINS2000 Series

4.3.2.4.2 1300 Series Engine

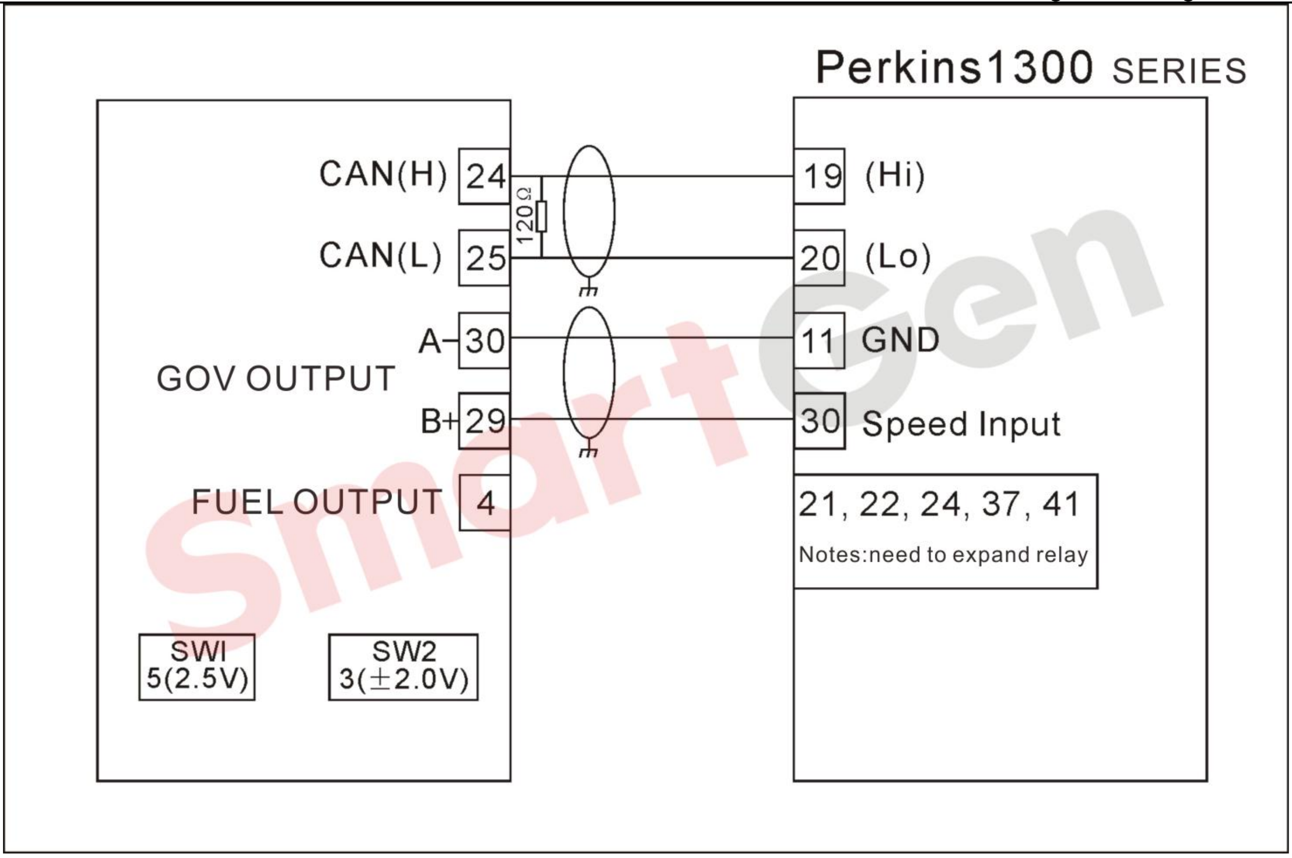


Fig. 110 PERKINS1300 Series

4.3.2.5 AMBAC

4.3.2.5.1 EC5000*/EC5100*/EC5110*

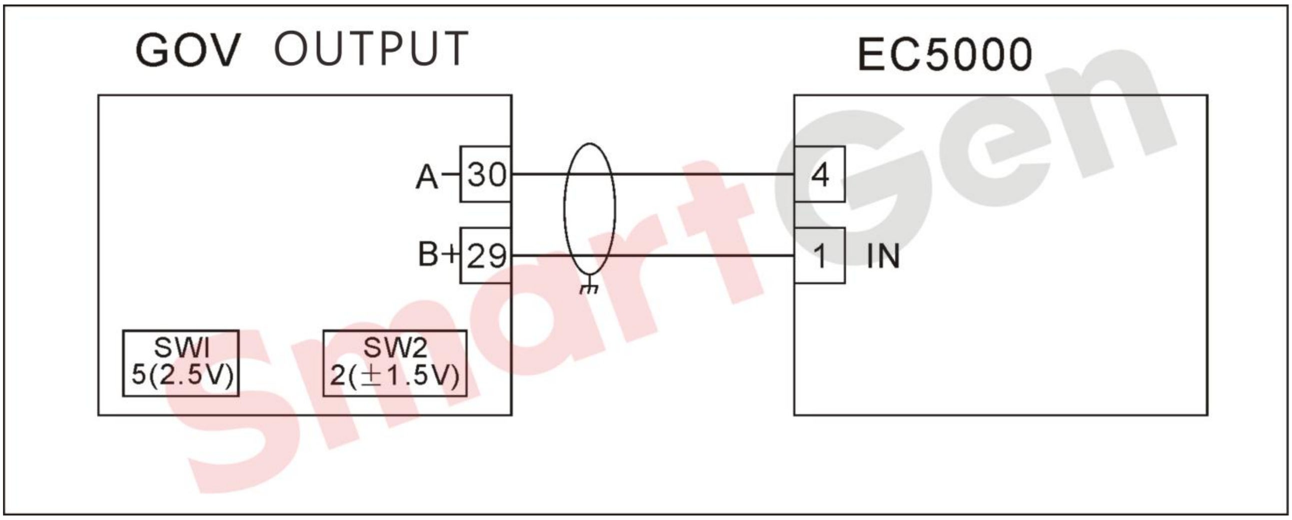


Fig. 111 AMBAC(EC5000*)

4.3.2.5.2 CW673C

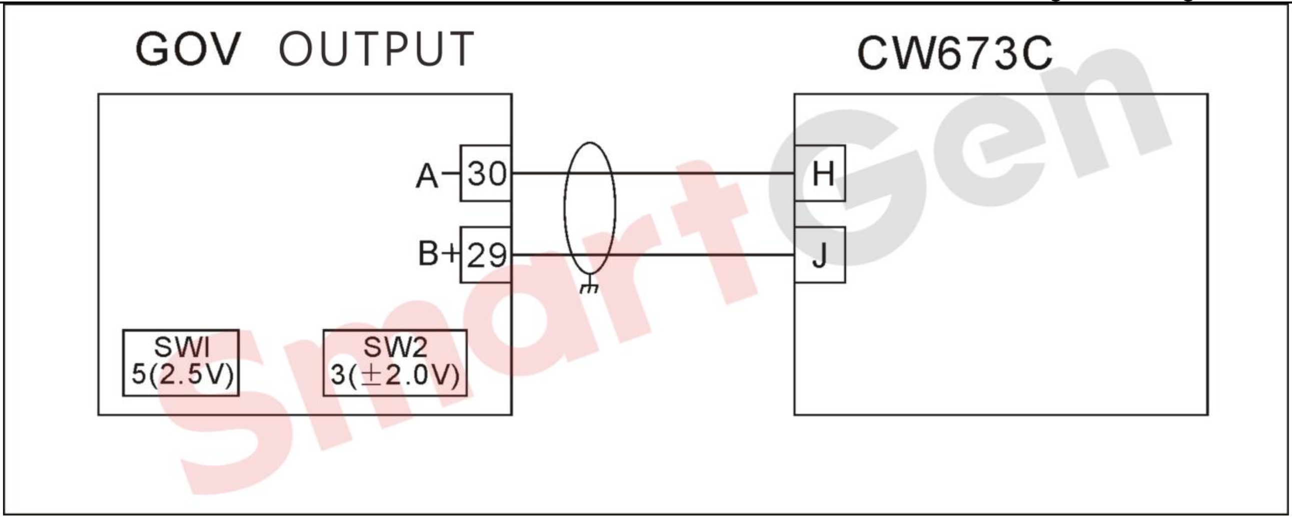


Fig. 112 AMBAC(CW673C)

4.3.2.6 BARBERCOLMAN

4.3.2.6.1 DYN110502/10503/10504/10506

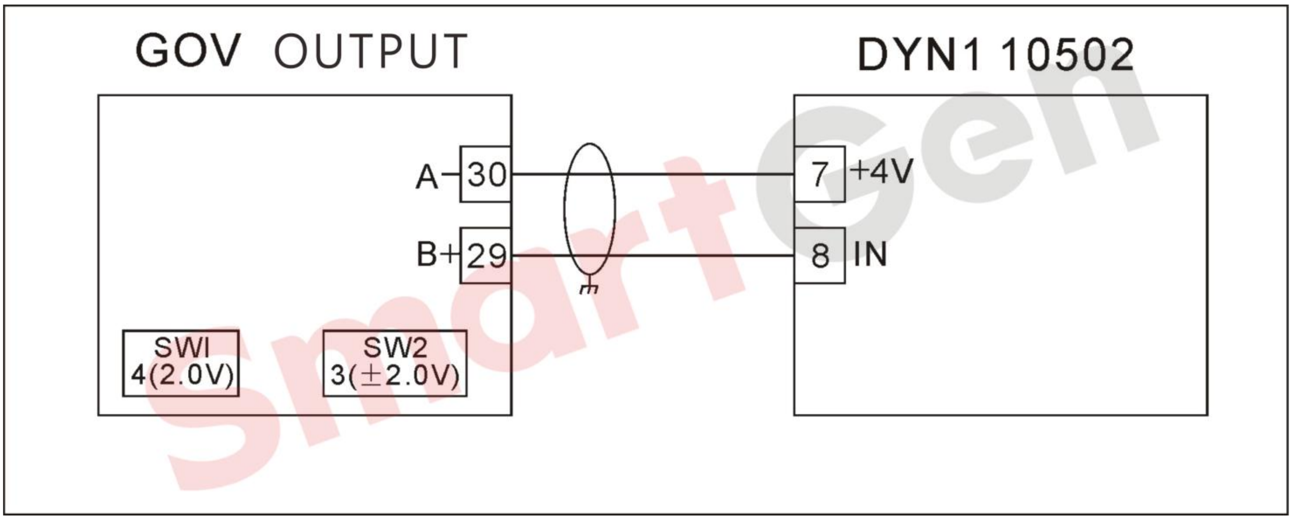


Fig. 113 BARBERCOLMAN(DYN110502)

4.3.2.6.2 DYN110693/10694/10695/10752/10753/10754/10756

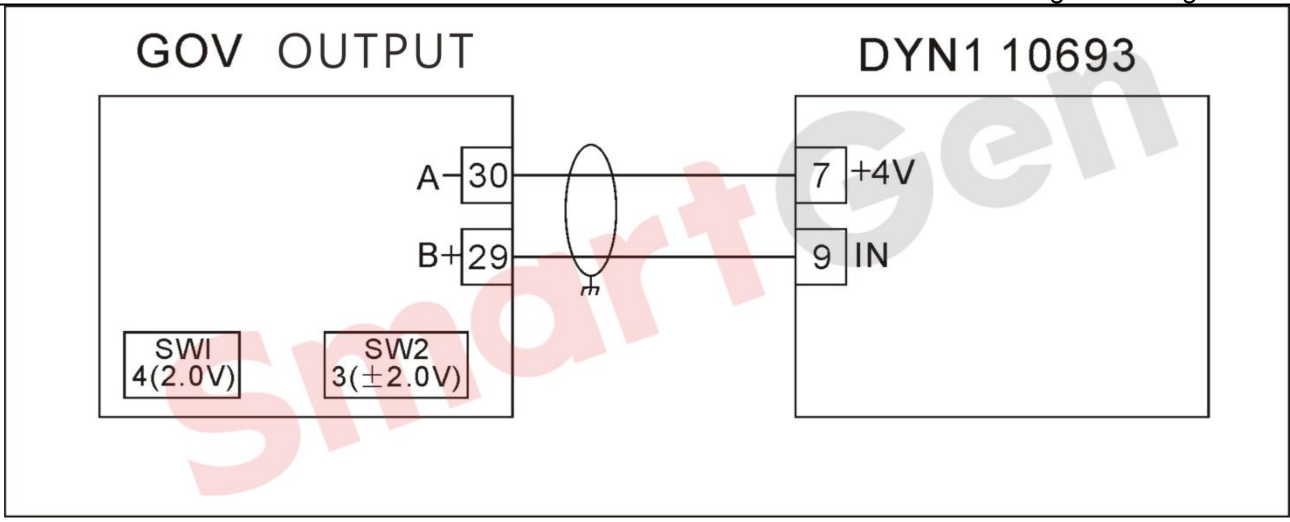


Fig. 114 BARBERCOLMAN(DYN110693)

4.3.2.6.3 DYN110794*

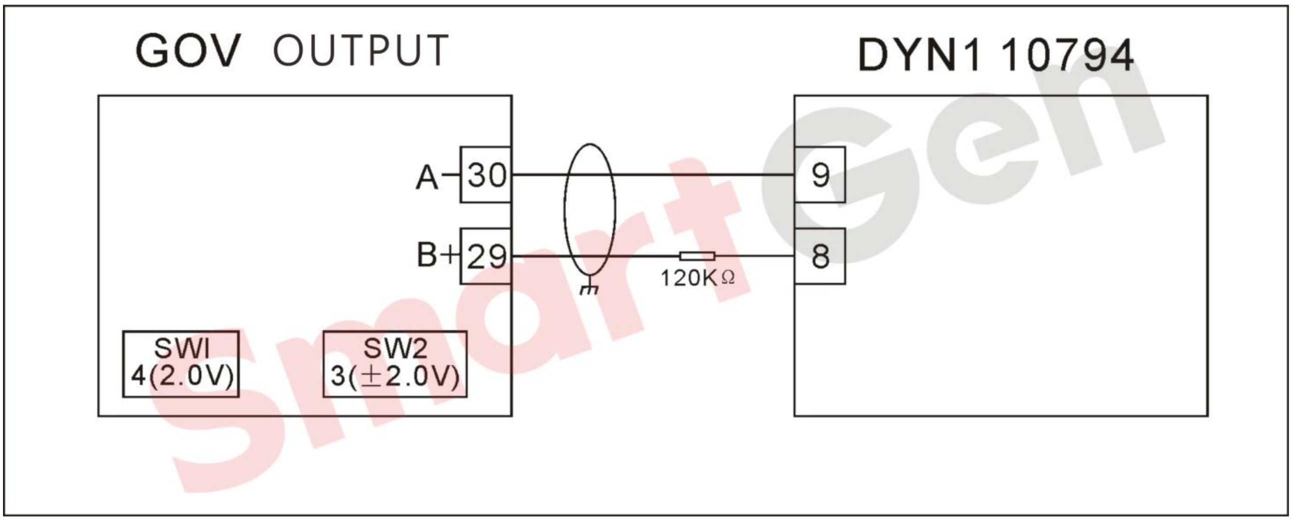


Fig. 115 BARBERCOLMAN(DYN110794*)

4.3.2.6.4 DYN110871

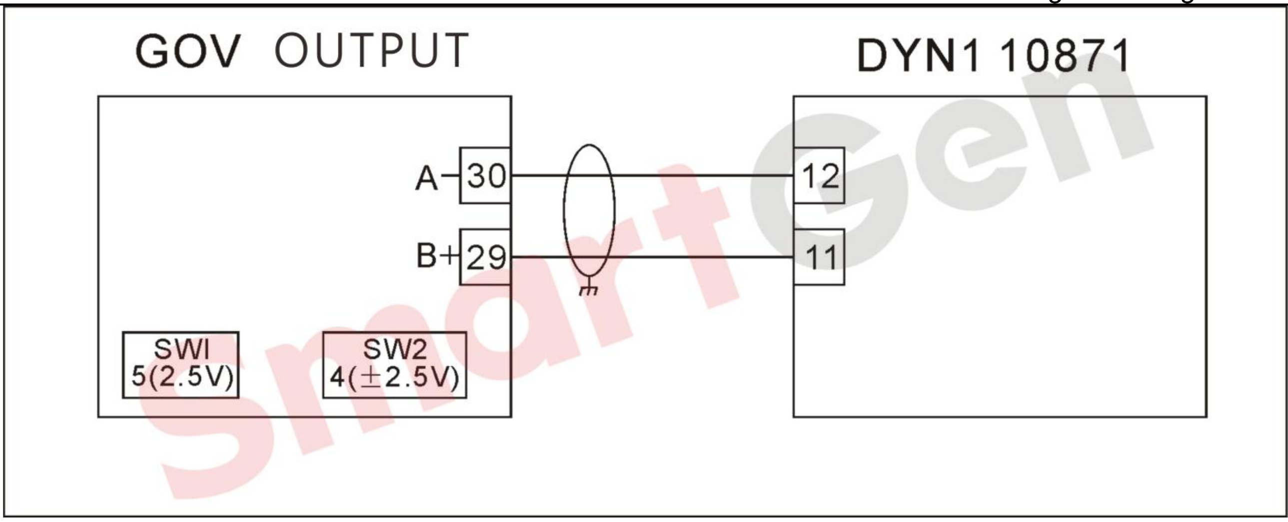


Fig. 116 BARBERCOLMAN(DYN110871)

4.3.2.6.5 DPG2201*

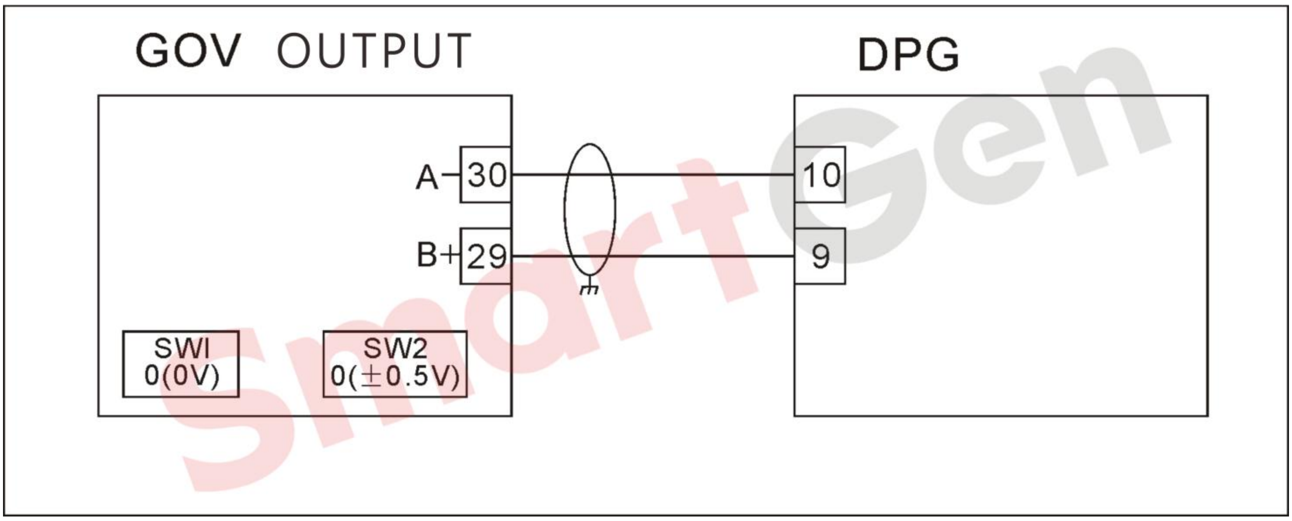


Fig. 117 BARBERCOLMAN(DPG2201*)

4.3.2.6.6 DPG2401

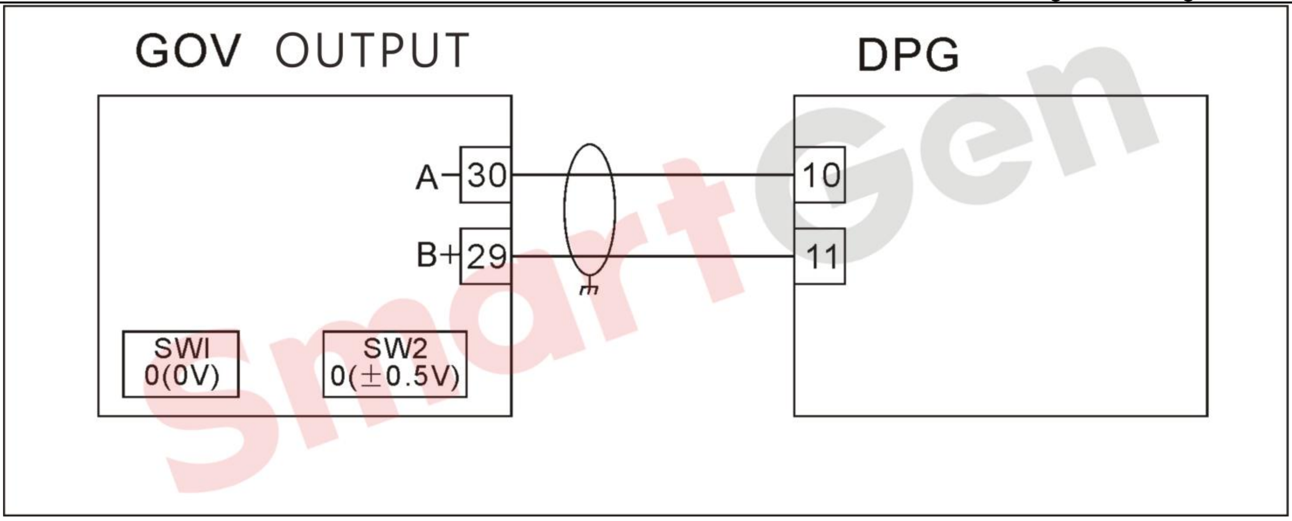


Fig. 118 BARBERCOLMAN(DPG2401)

4.3.2.6.7 DYNA8000*

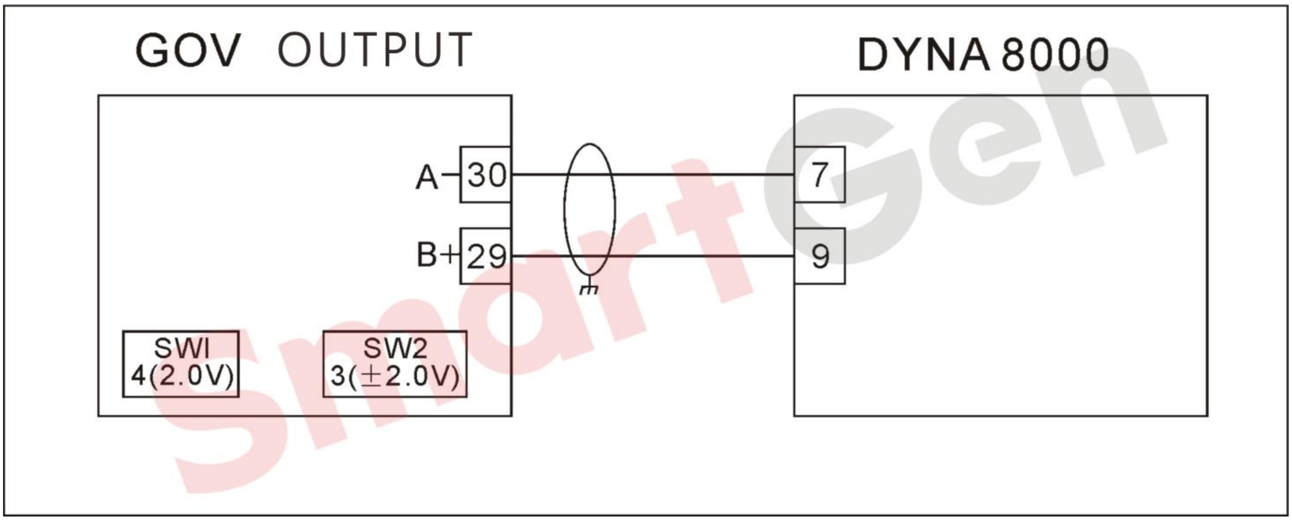


Fig. 119 BARBERCOLMAN(DYNA8000*)

4.3.2.7 CATERPILLAR ADEM*

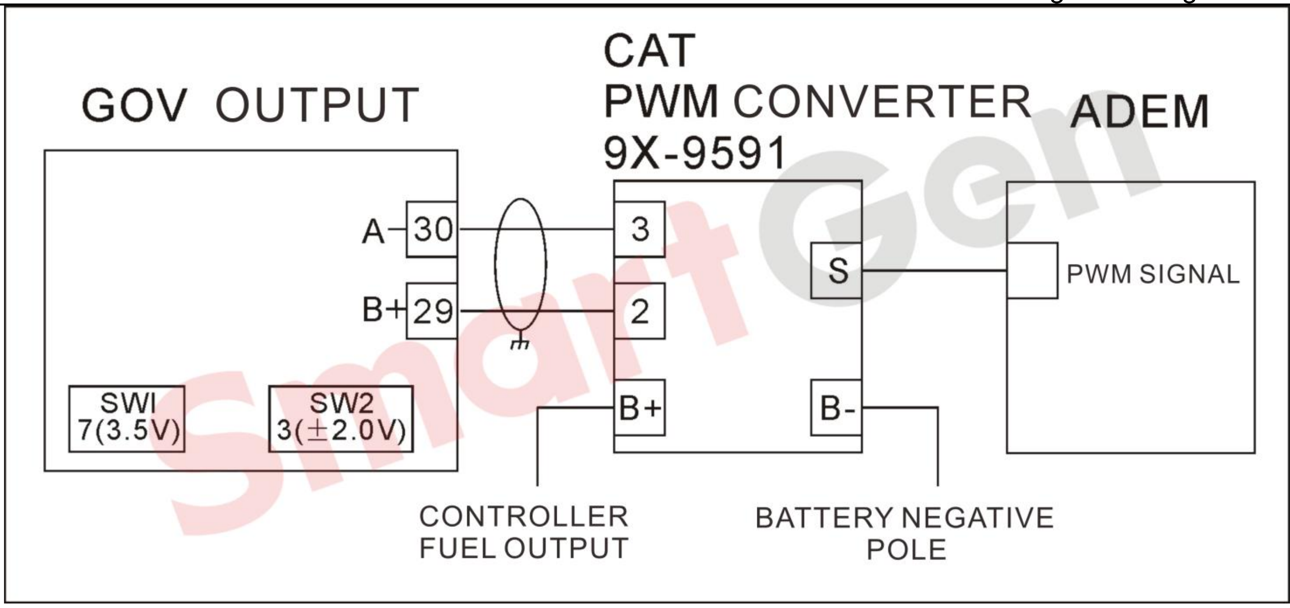


Fig. 120 CATERPILLAR ADEM*

4.3.2.8 DETROIT

4.3.2.8.1 DDECIII

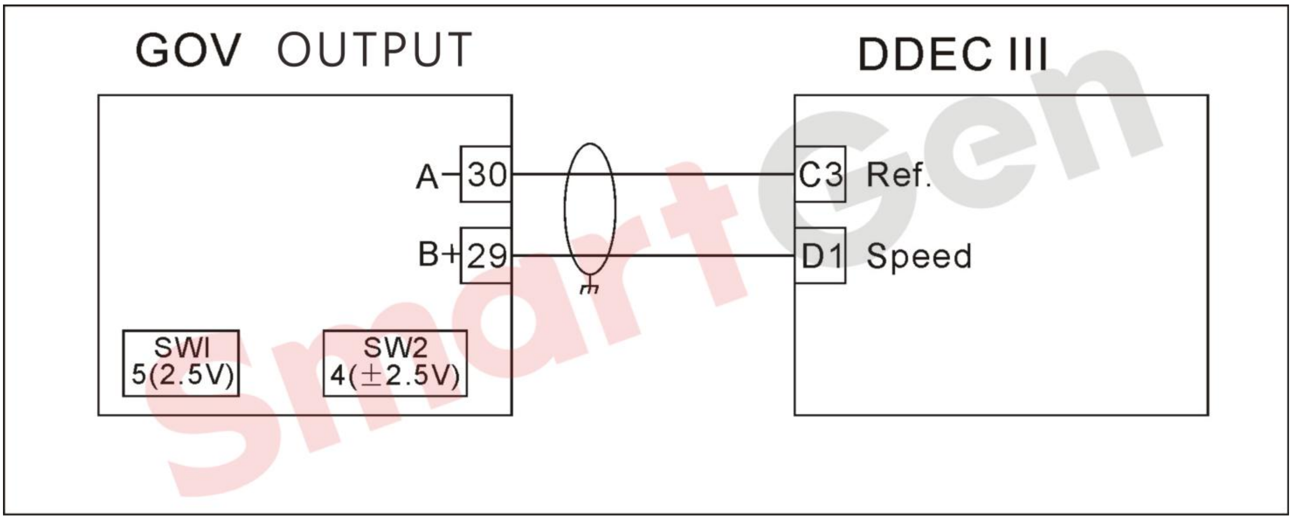


Fig. 121 DETROIT DDECIII

4.3.2.8.2 DDECIV*

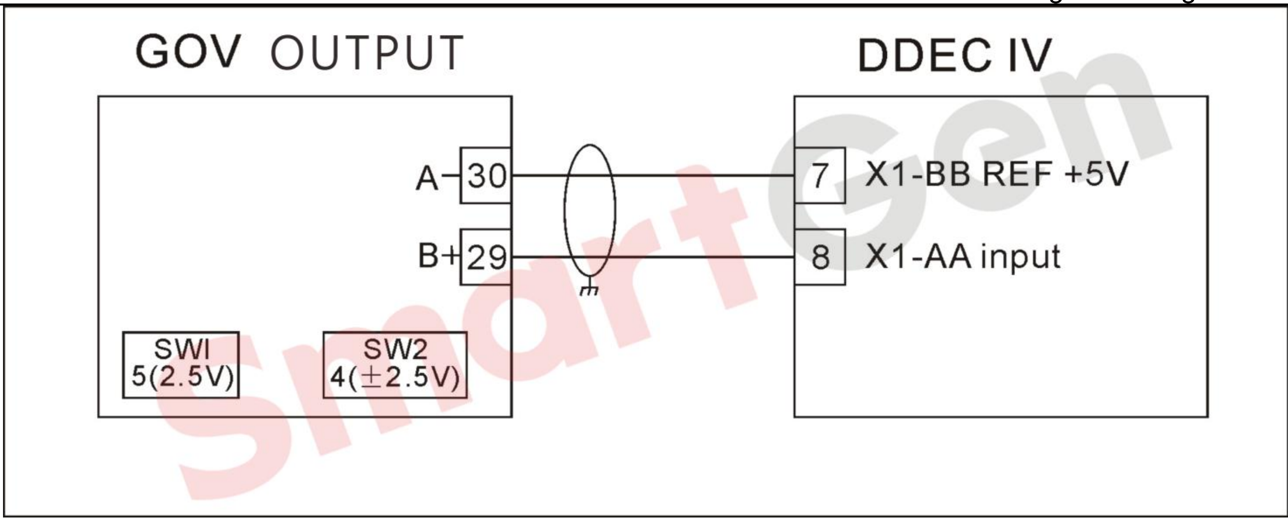


Fig. 122 DETROIT DDECIV*

4.3.2.9 DEUTZ EMR2

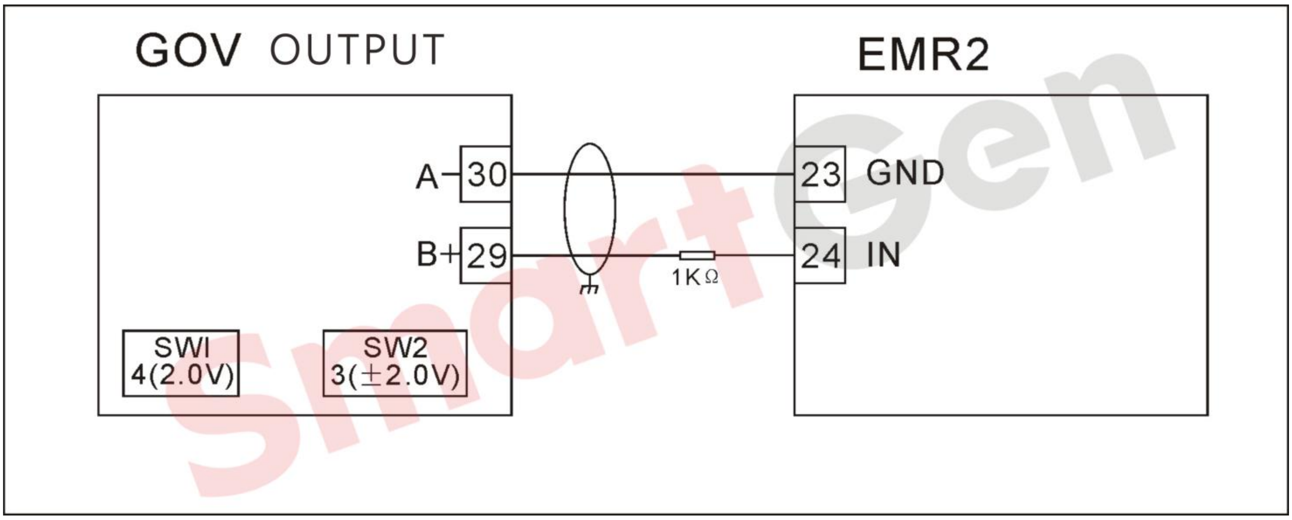


Fig. 123 DEUTZ EMR2

4.3.2.10 DOOSAN DGC

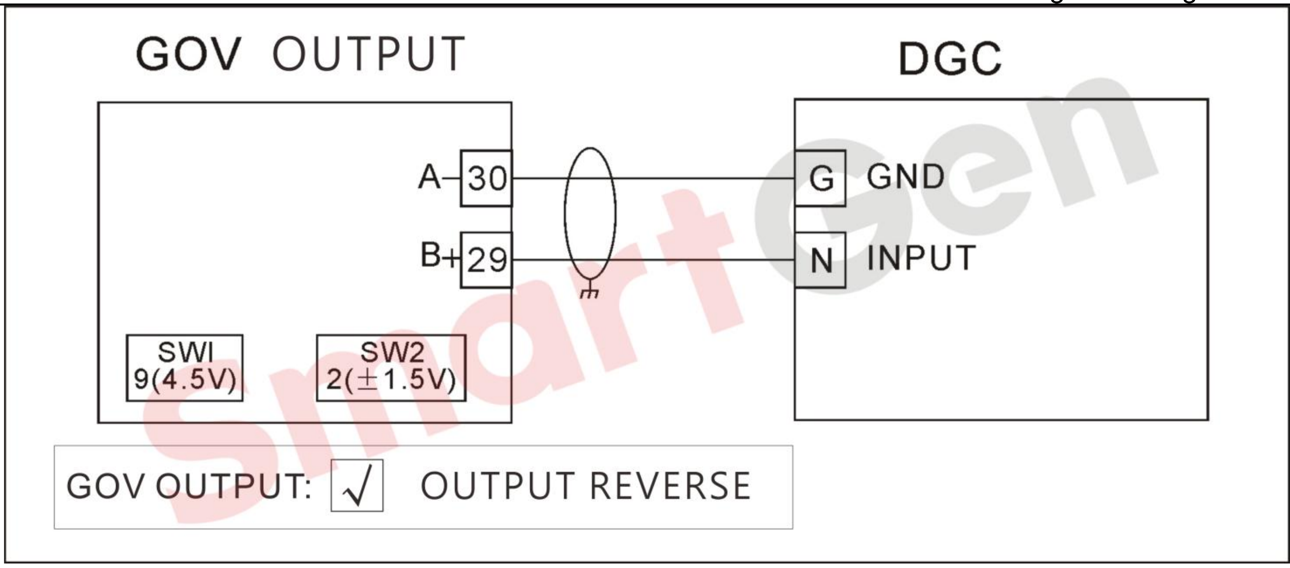


Fig. 124 DOOSAN DGC

4.3.2.11 GHANACONTROLDGC-2007*

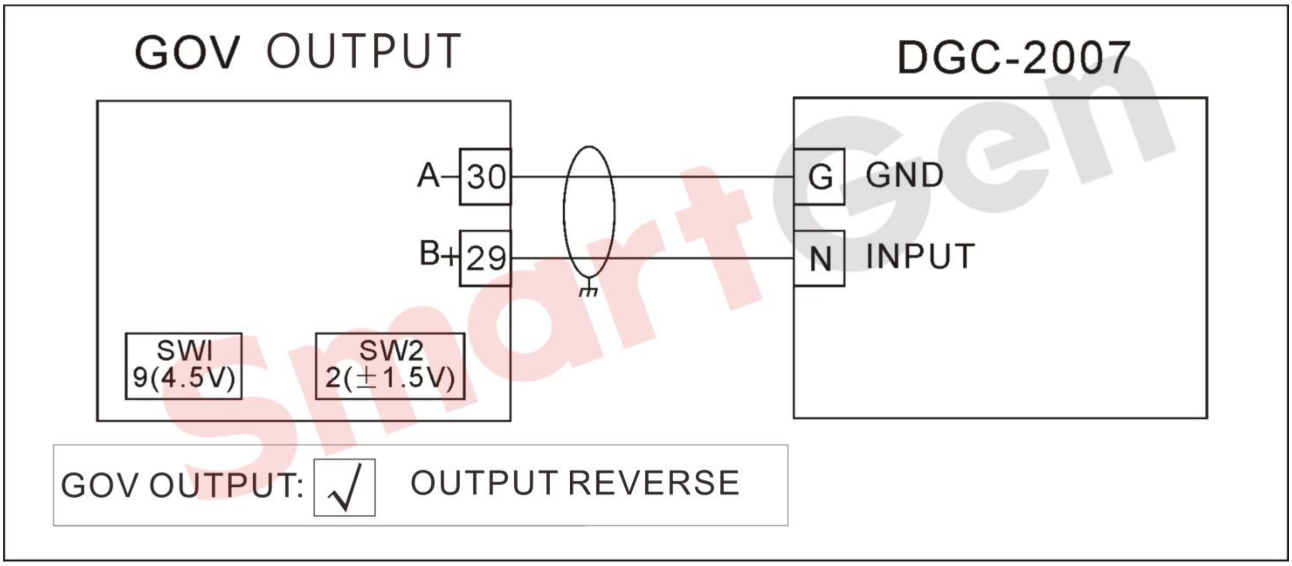


Fig. 125 GHANACONTROLDGC-2007*

4.3.2.12 HEINZMANN

4.3.2.12.1 KG Series

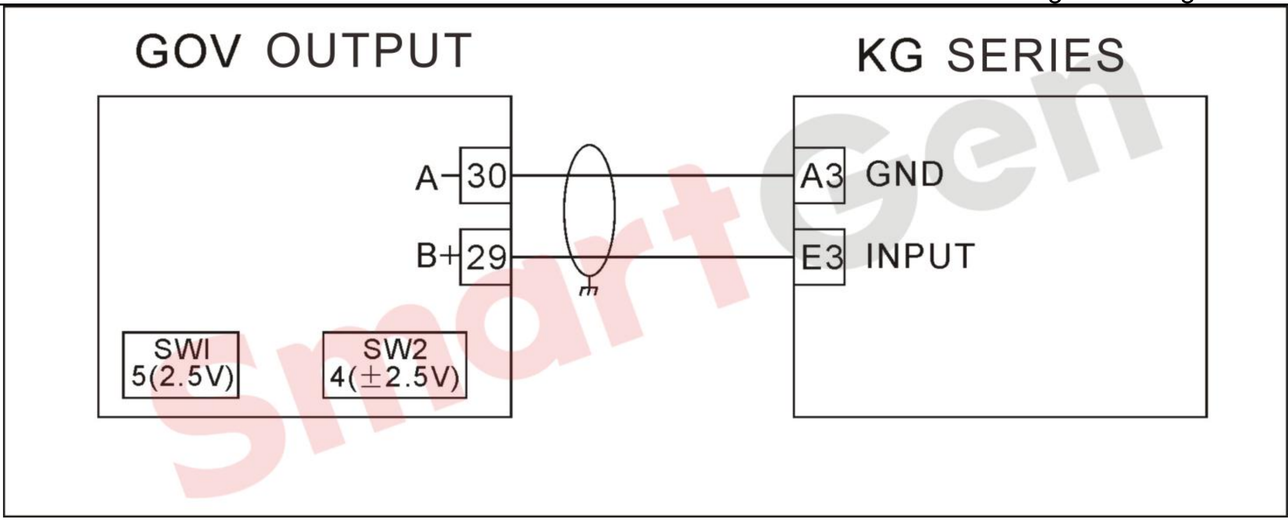


Fig. 126 HEINZMANN KG Series

4.3.2.12.2 PANDAROS*

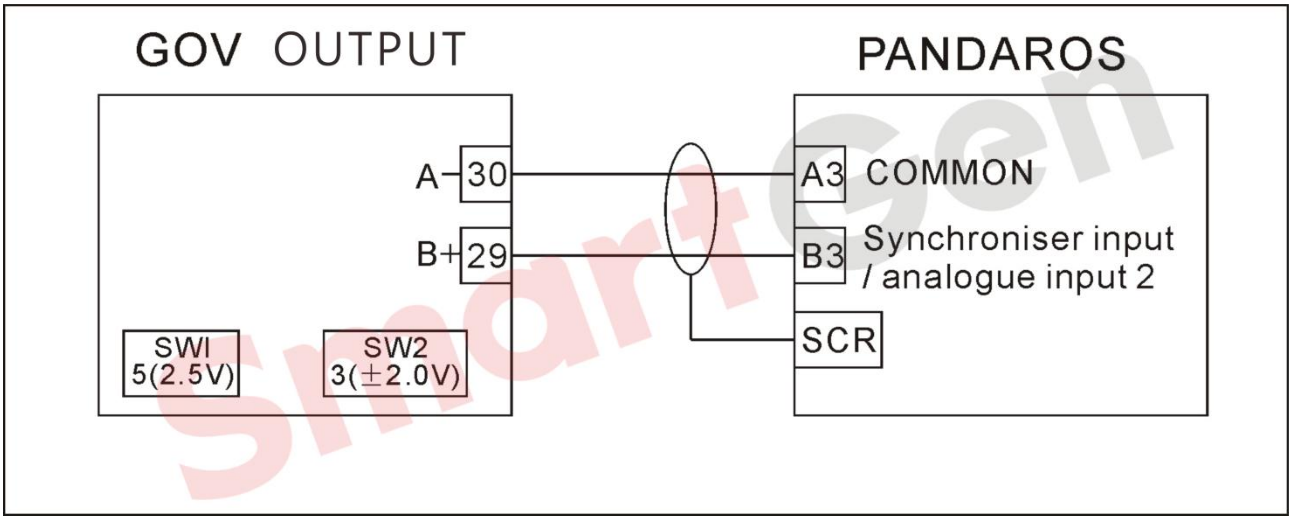


Fig. 127 HEINZMANN PANDAROS*

Note: Pandaros need to be configured in "PandarosPackager" software:

——Single unit/parallel without sagging.

——Analog Input 1 (Load Sharing) is not enabled.

——Analog Input 2 (Synchronous Input) is configured as 0-5V input.

4.3.2.13 IVECO CURSOR13TE2(WITHSCIBOX)*

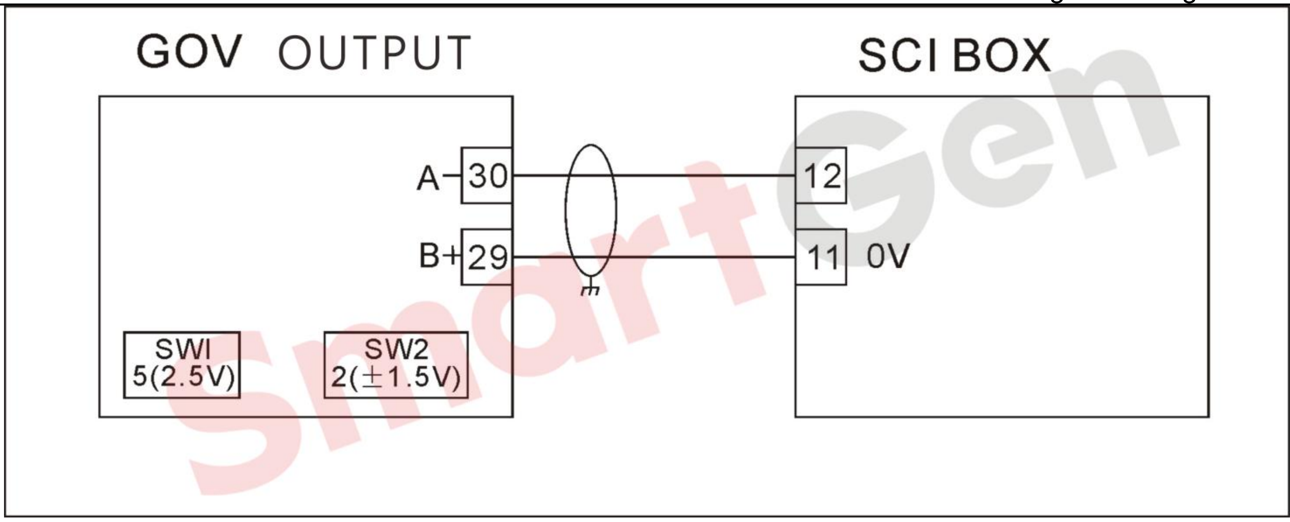


Fig. 128 IVECO SCIBOX

Note: The dial switch in SCI box is set as follows:1=OFF, 2=ON, 3=OFF, 4=OFF

4.3.2.14 JOHNDEERE JDEC

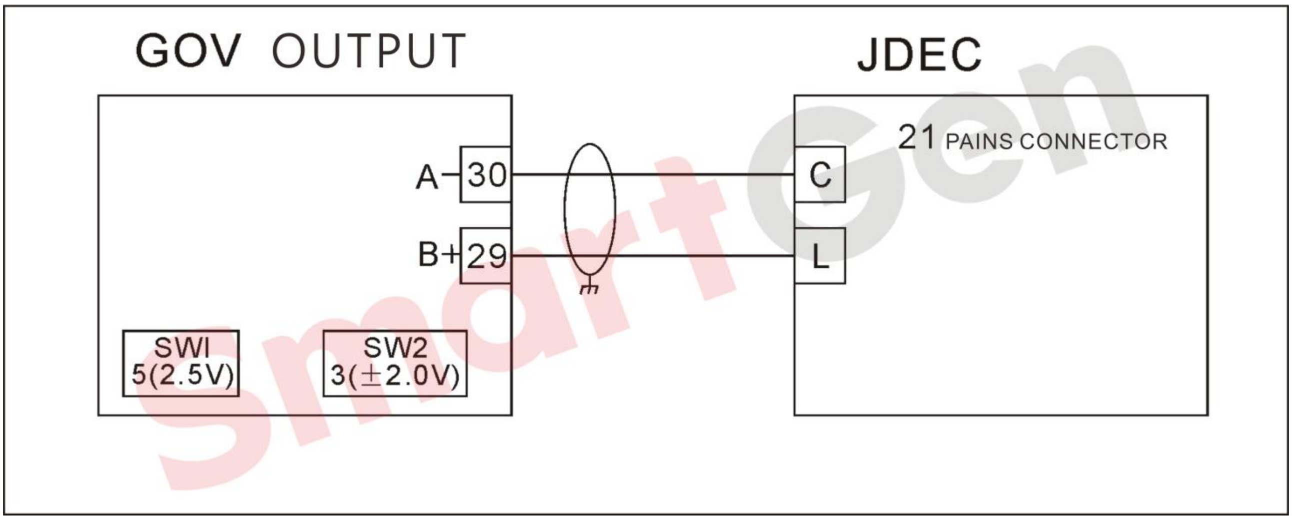


Fig. 129 JOHNDEERE JDEC

4.3.2.15 MITSUBISHI XB400*

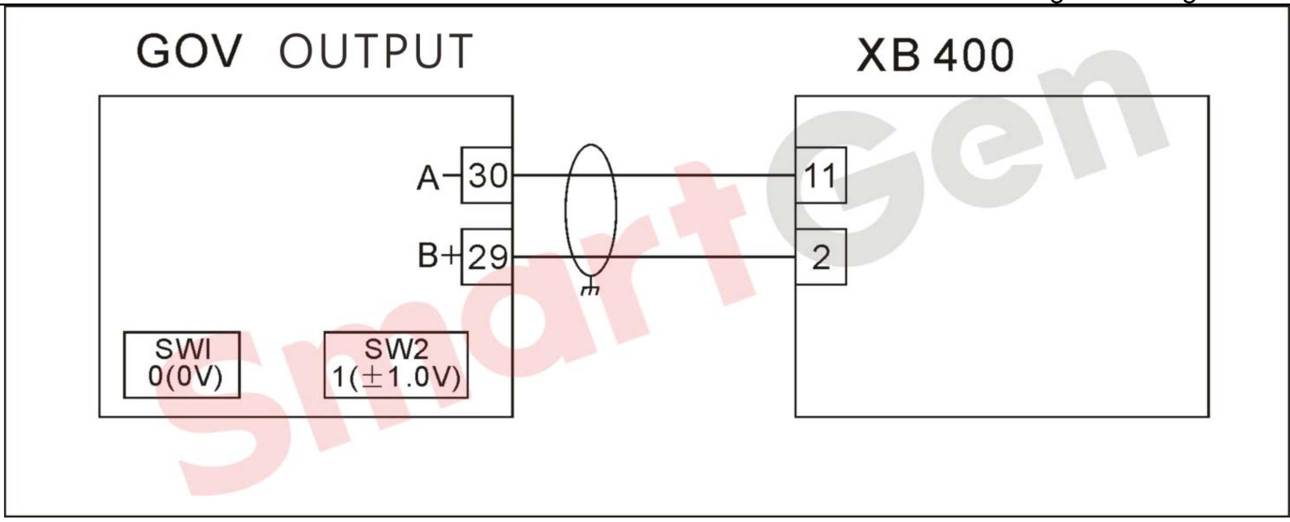


Fig. 130 MITSUBISHIXB400*

4.3.2.16 MTUADEC2000*/4000

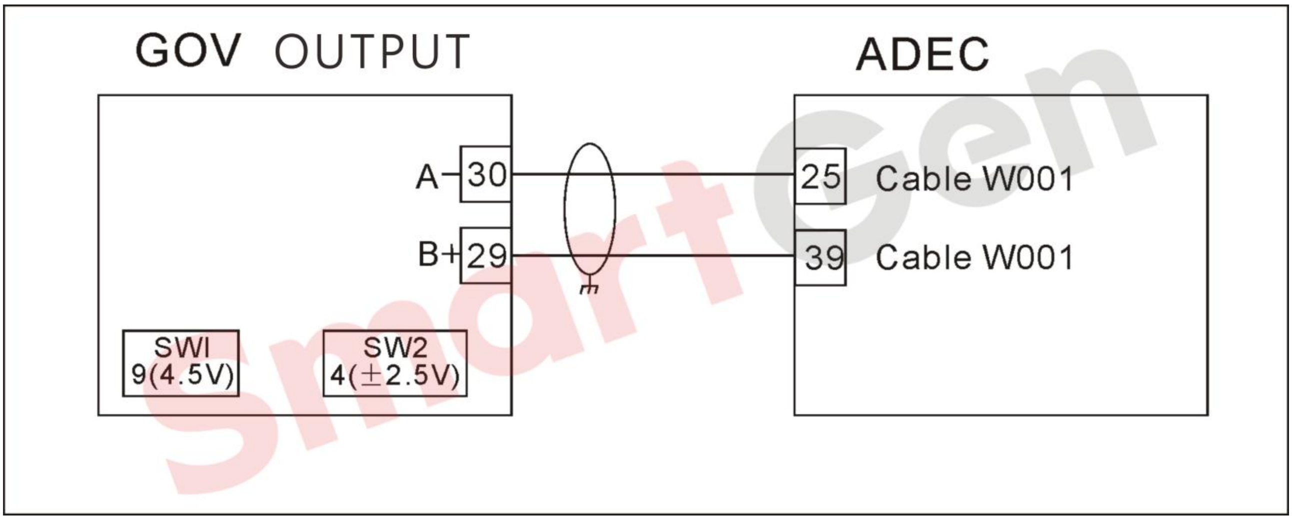


Fig. 131 MTU(ADEC2000*/4000)

4.3.2.17 SCANIA S6 Engine

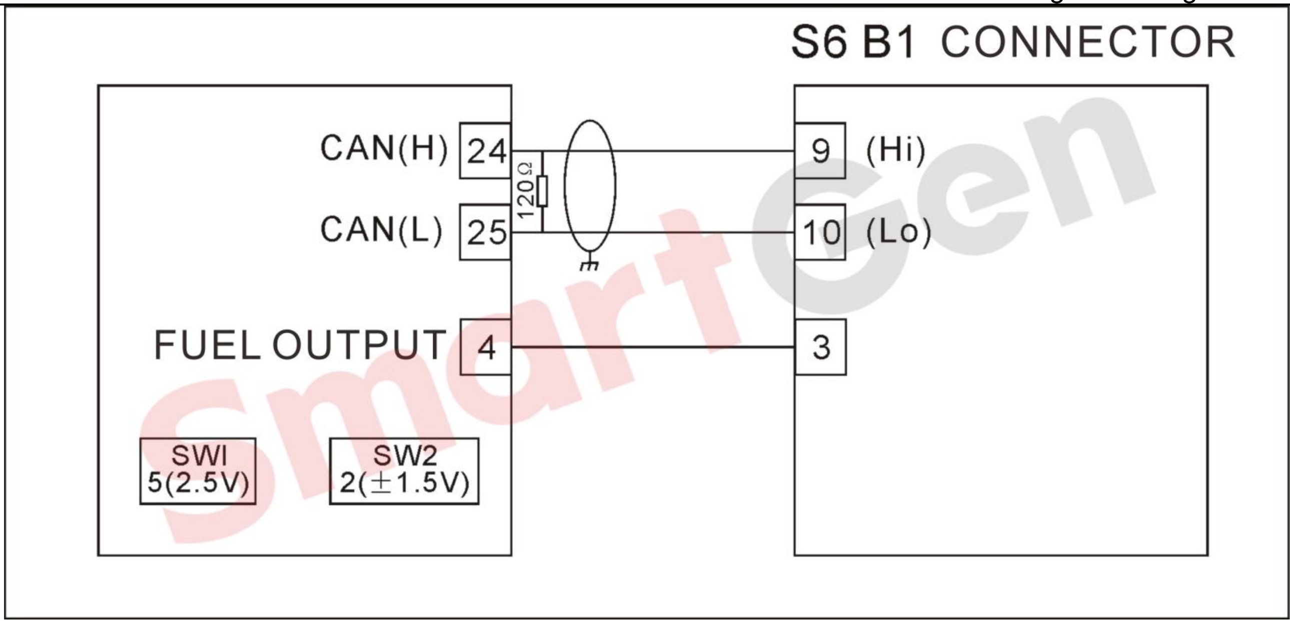


Fig. 132 SCANIA S6 Engine

4.3.2.18 TOHO1TOHOXS*

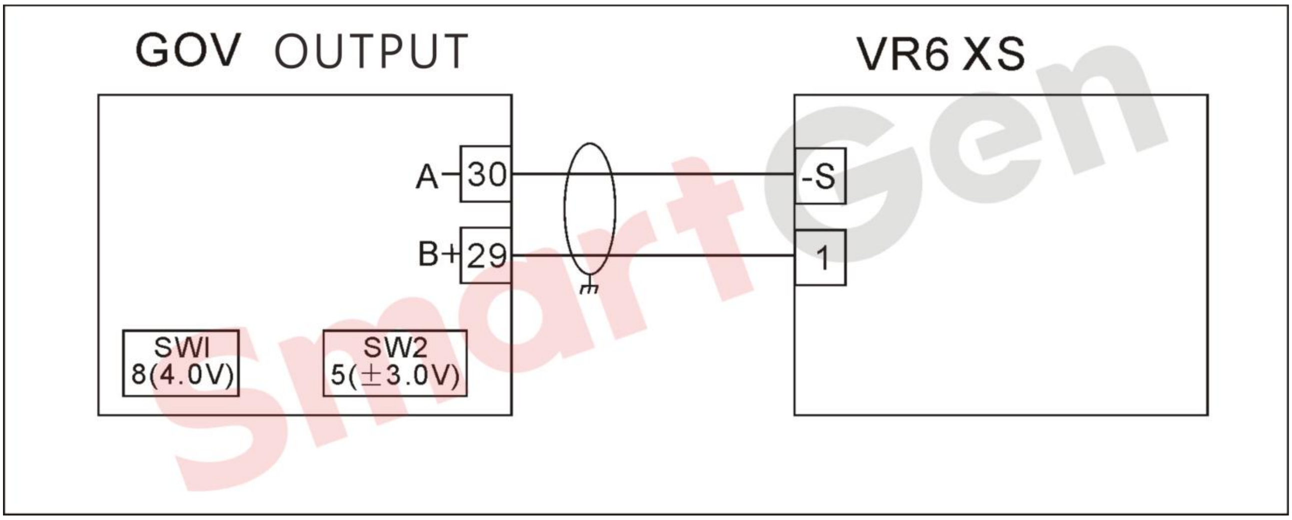


Fig. 133 TOHOXS*

4.3.2.19 WOODWARD

4.3.2.19.1 721 Digital GOV

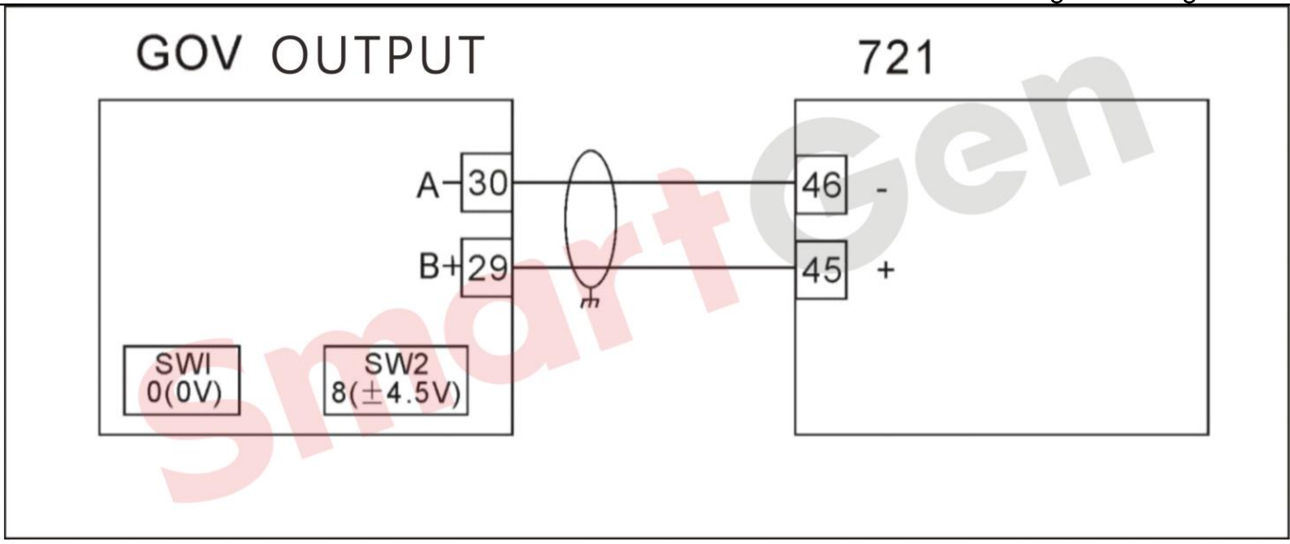


Fig. 134 WOODWARD 721 Digital GOV

4.3.2.19.2 2301A GOV

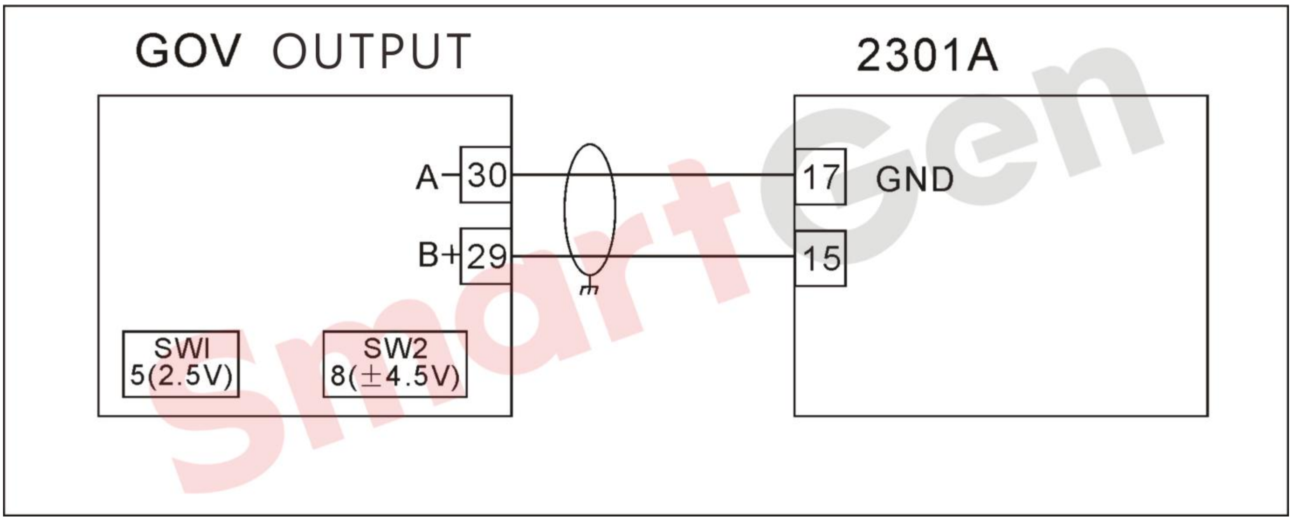


Fig. 135 WOODWARD 2301A GOV

4.3.2.19.3 2301A Load Sharing

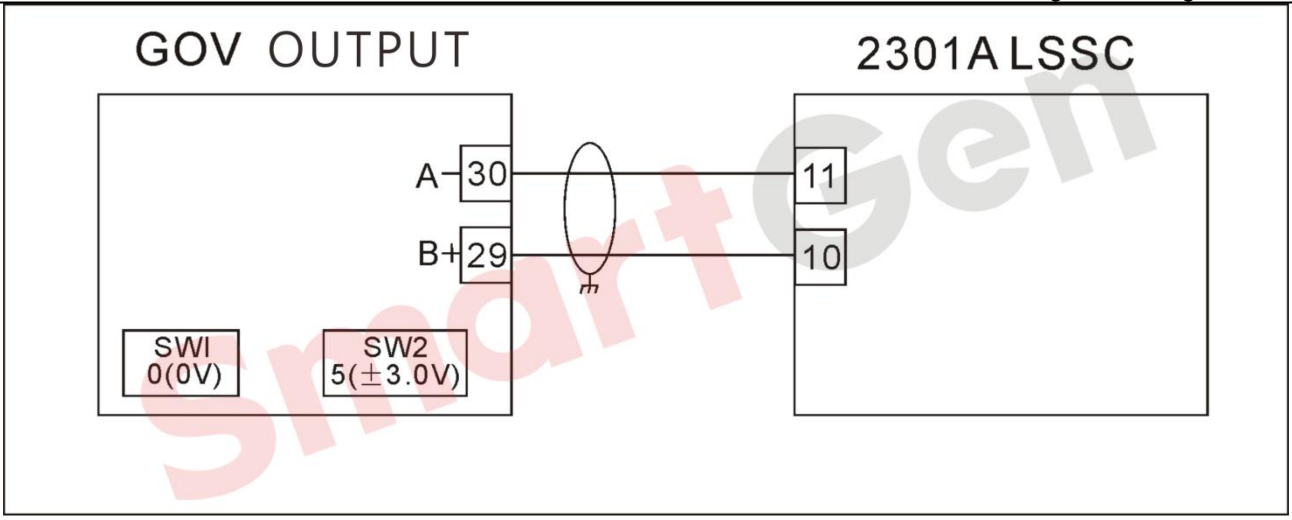


Fig. 136 WOODWARD 2301A Load Sharing

4.3.2.19.4 DPG

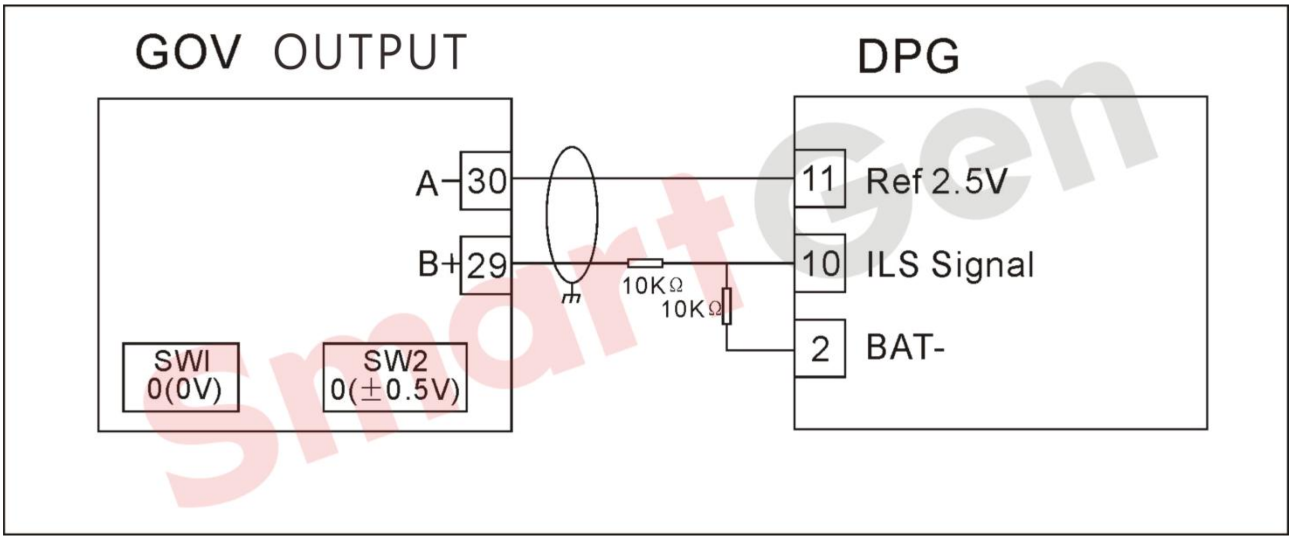


Fig. 137 WOODWARD DPG

4.3.2.19.5 EPG(ELECTRICALLYPOWEREDGOVERNORS)*

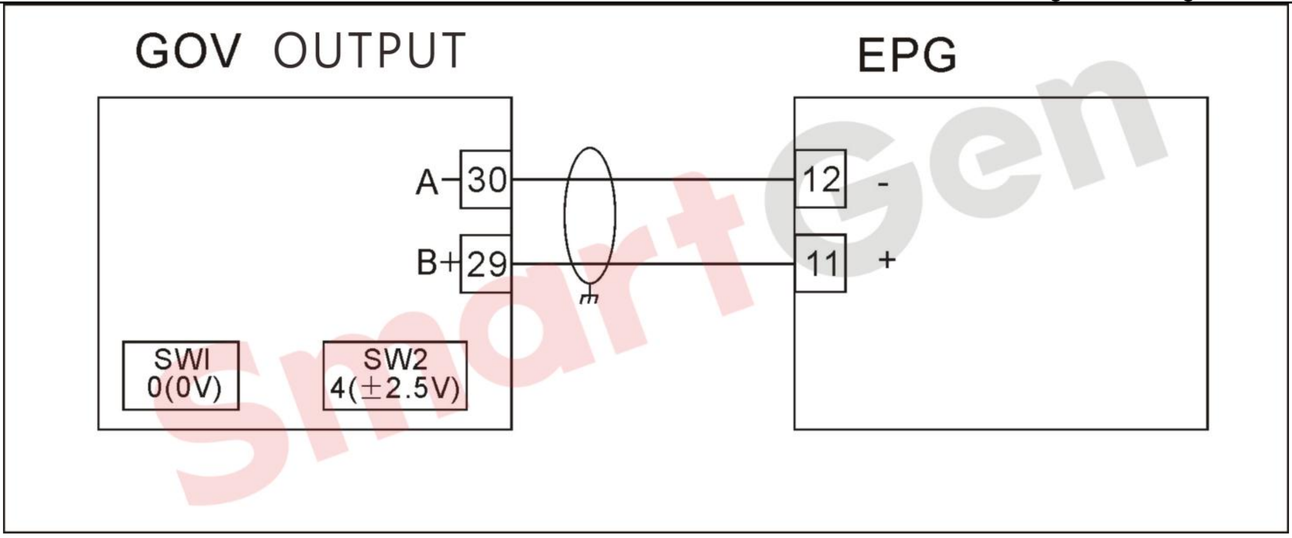


Fig. 138 WOODWARD EPG

4.3.2.19.6 PROACTI/II

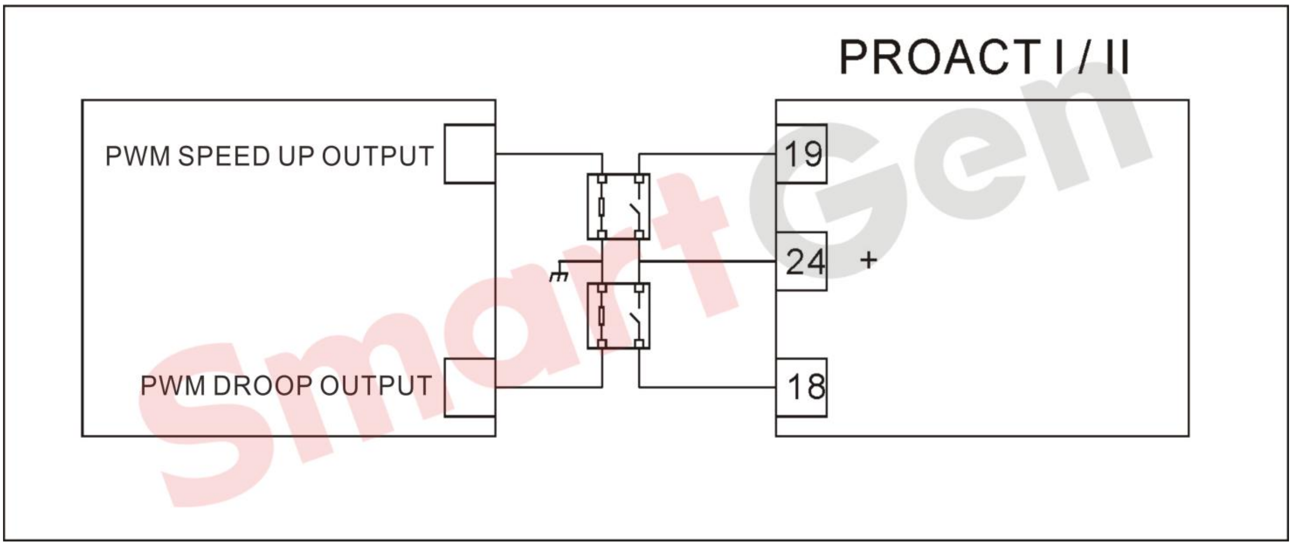


Fig. 139 WOODWARD PROACTI/II

4.3.3 AVR Connection

4.3.3.1 STAMFORD

SX421/SX440*/SX465-2/AS440/MX321/MX325/MX327/MX341

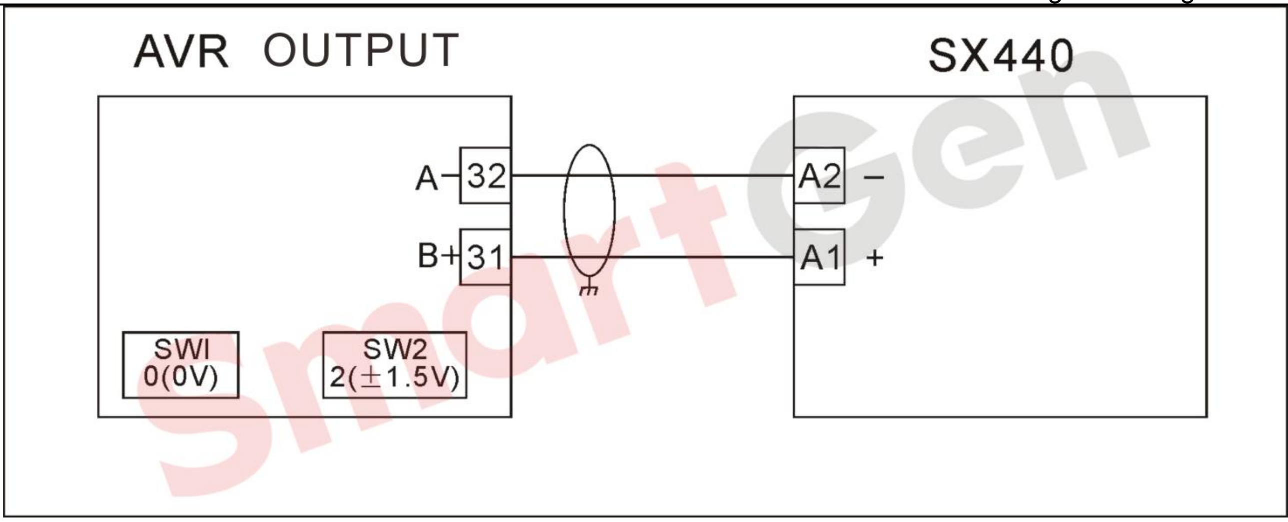


Fig. 140 STAMFORD SX440

4.3.3.2 MARATHON

4.3.3.2.1 DVR2000/DVR2000C

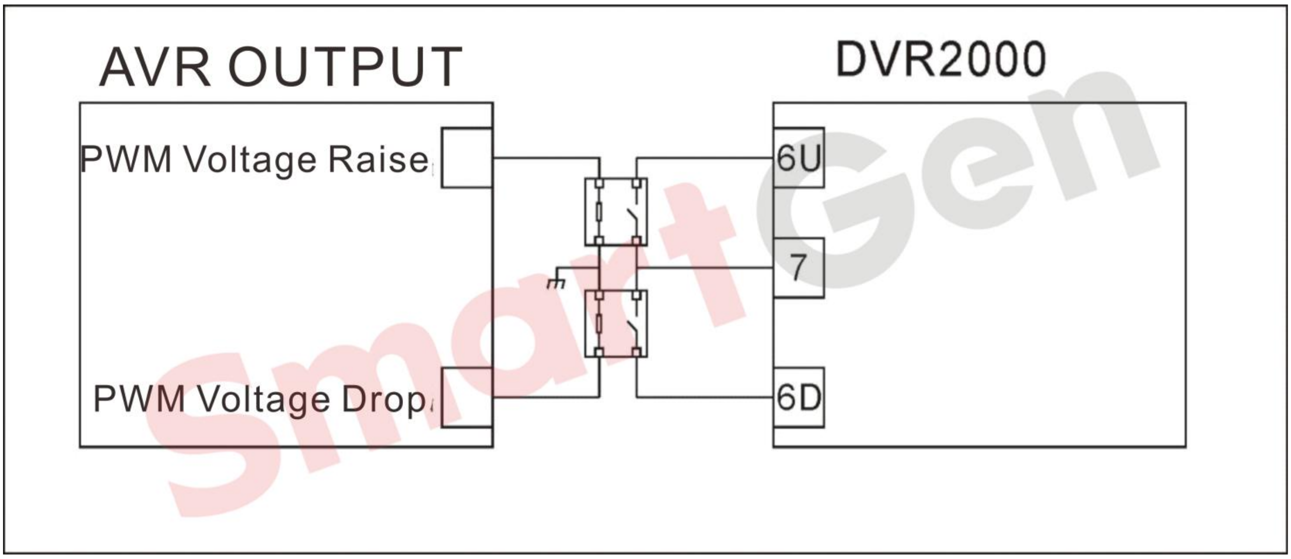


Fig. 141 MARATHON DVR2000

4.3.3.2.2 DVR2000E

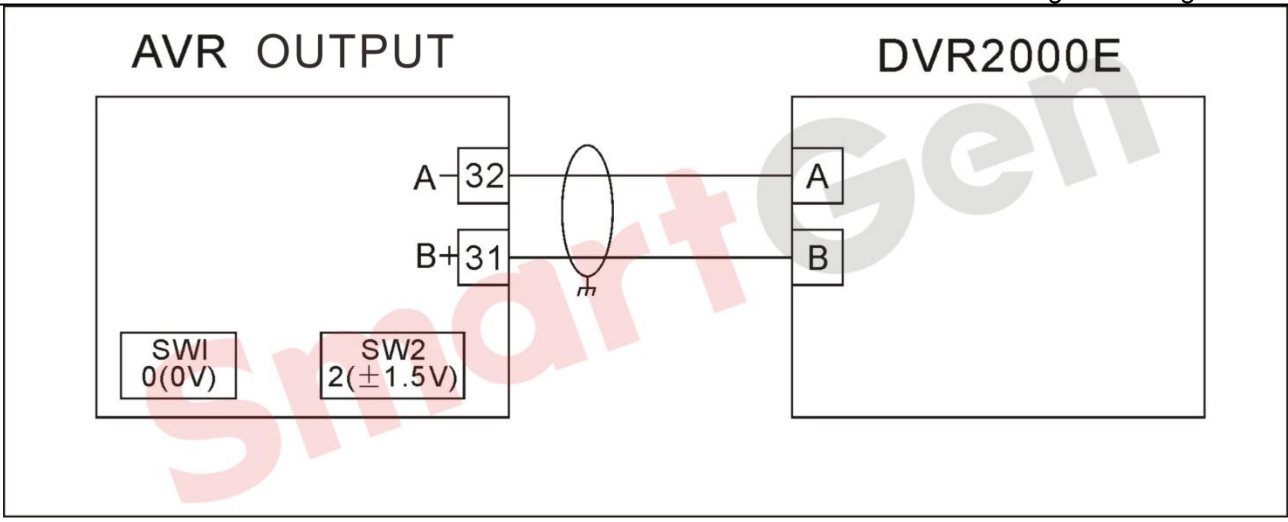


Fig. 142 MARATHON DVR2000E

4.3.3.2.3 PM100*/PM200*

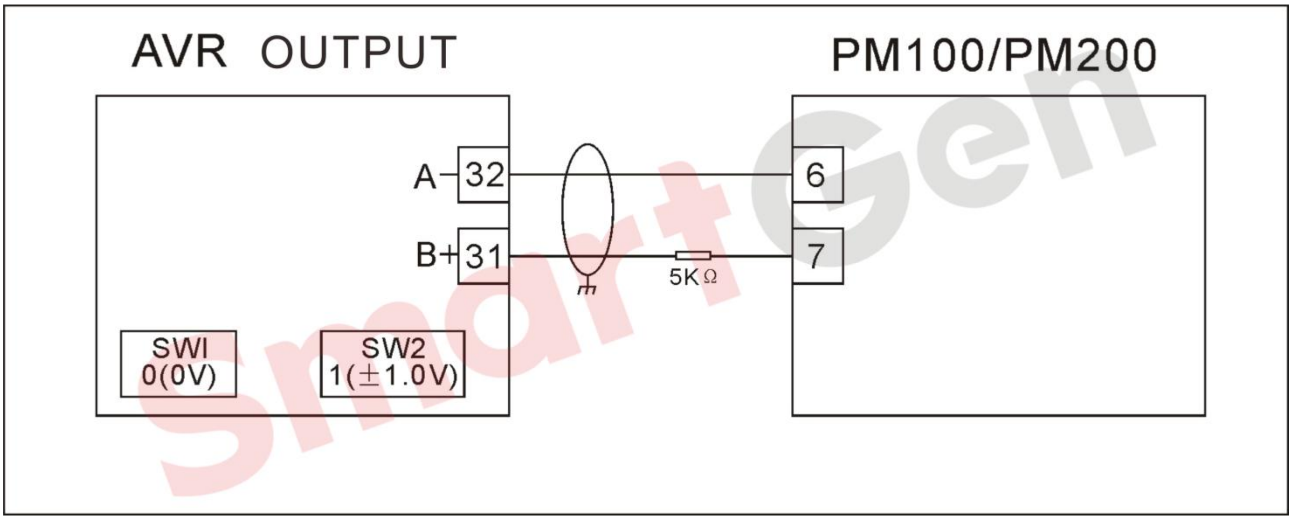


Fig. 143 MARATHON PM100*/PM200*

4.3.3.3 LEROYSOMER

4.3.3.3.1 R230/R438*/R448/R449

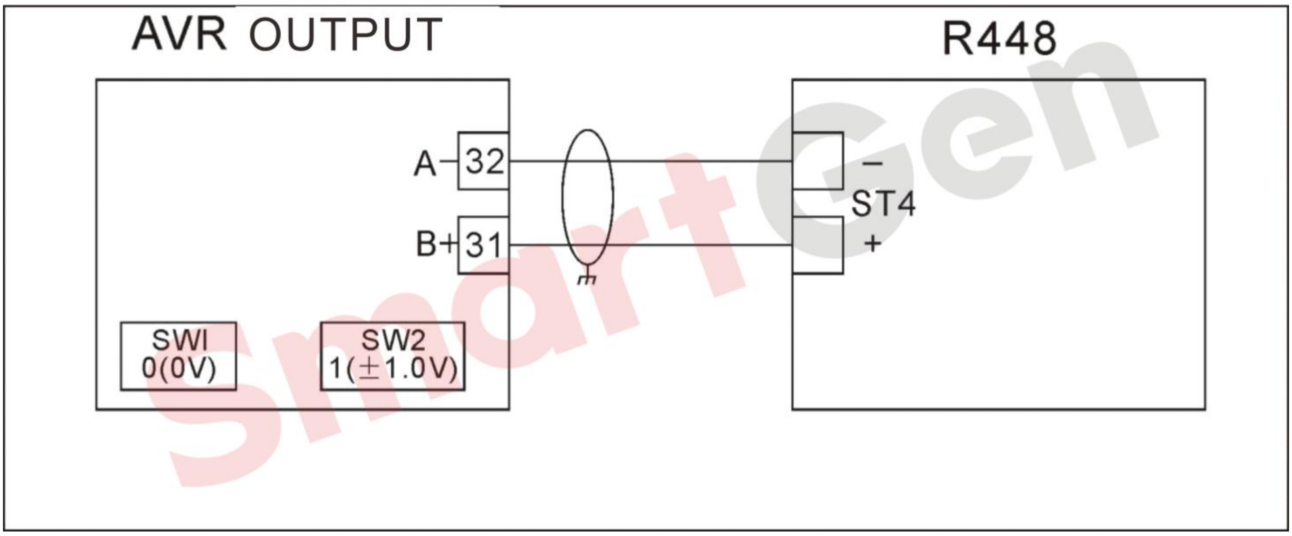


Fig. 144 LEROYSOMER R448

4.3.3.3.2 R6103F

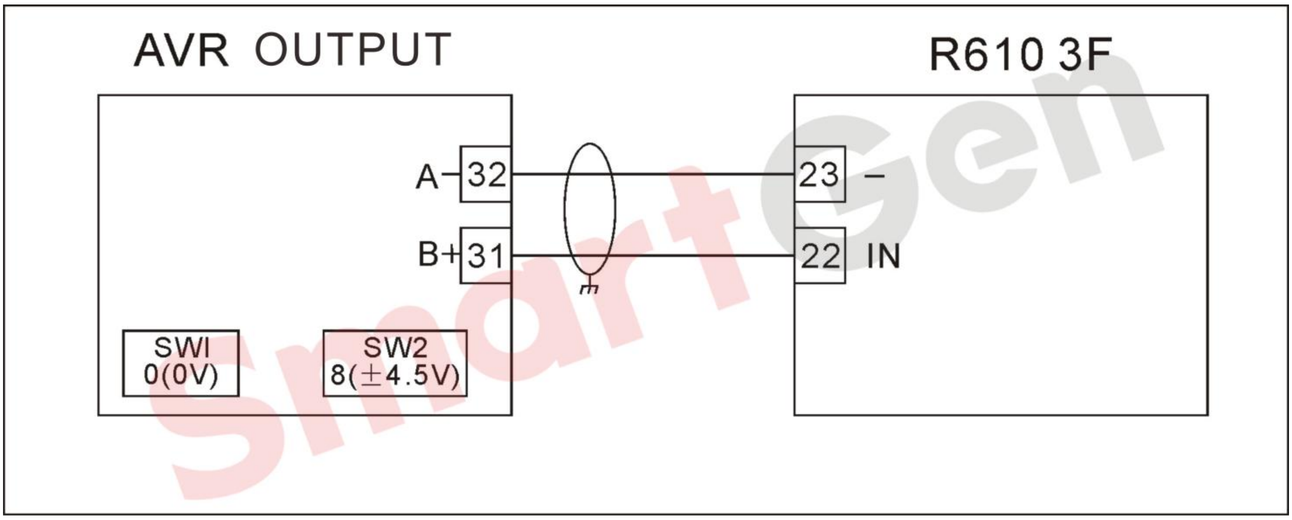


Fig. 145 LEROYSOMER R6103F

4.3.3.4 ENGGA

4.3.3.4.1 WT-2/WT-3

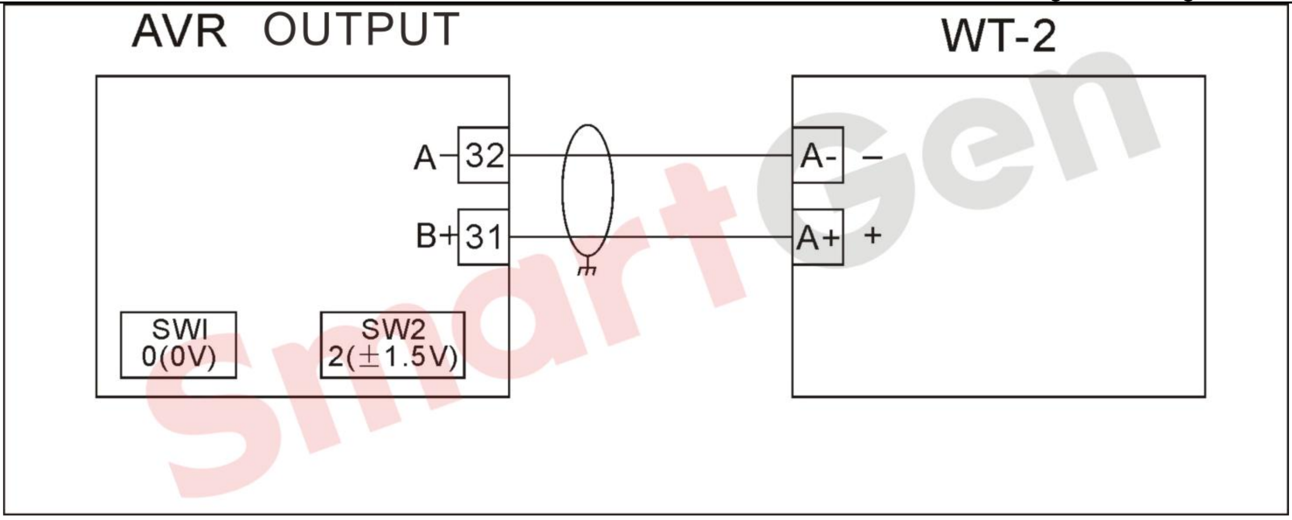


Fig. 146 ENGGA WT-2

4.3.3.4.2 MECCALTE

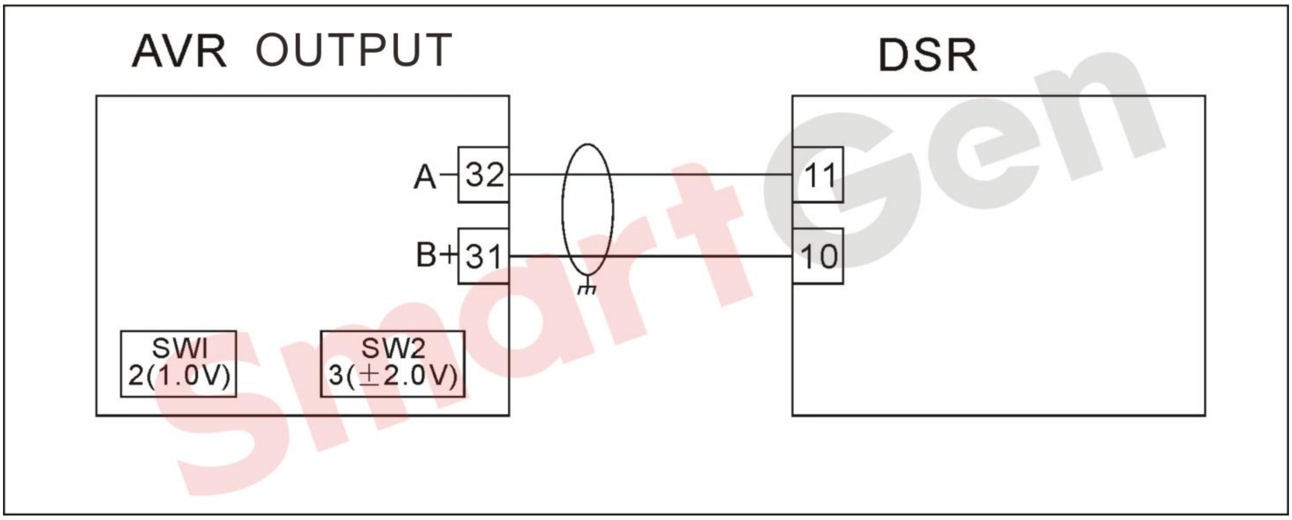


Fig. 147 MECCALTE DSR

4.3.3.4.3 S.R.7*

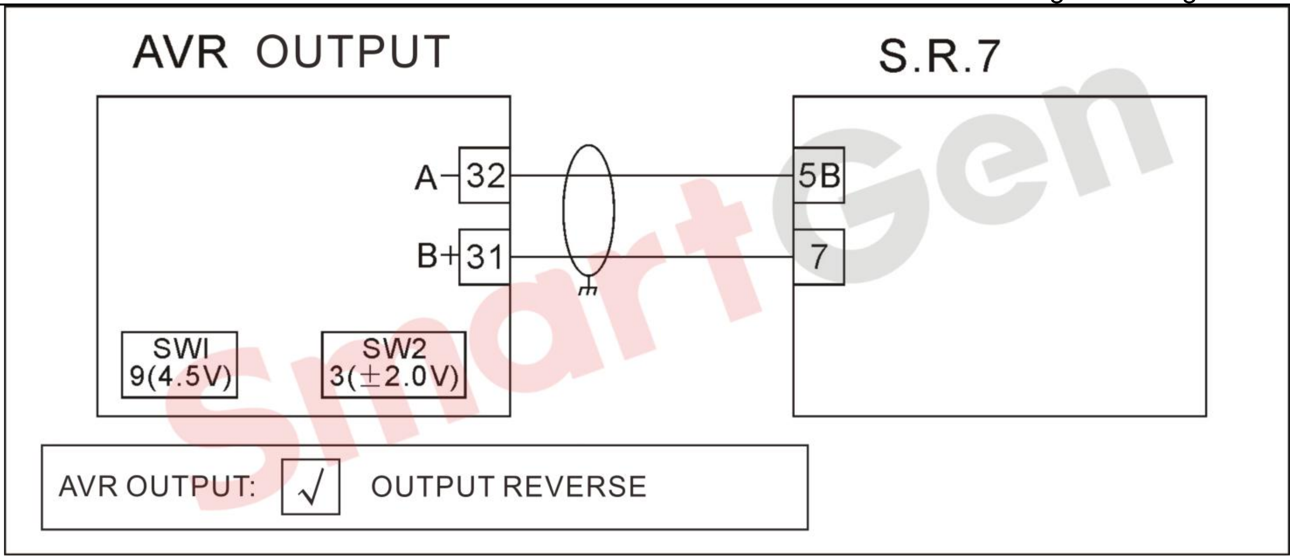


Fig. 148 MECCALTE S.R.7

4.3.3.4.4 U.V.R*

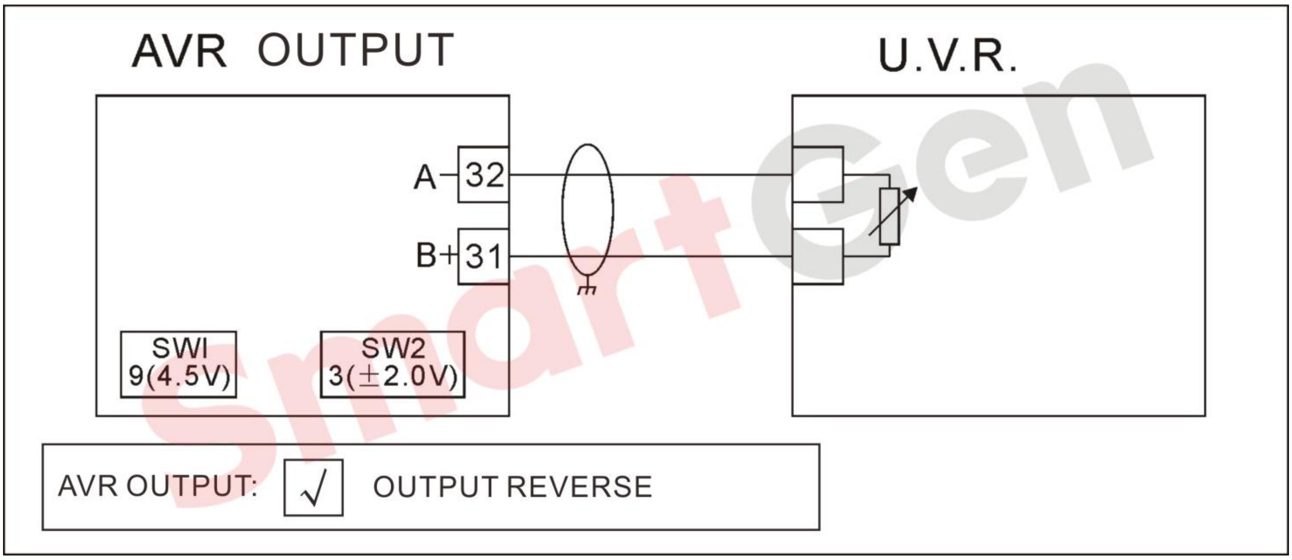


Fig. 149 MECCALTE U.V.R

4.3.3.4.5 DER1

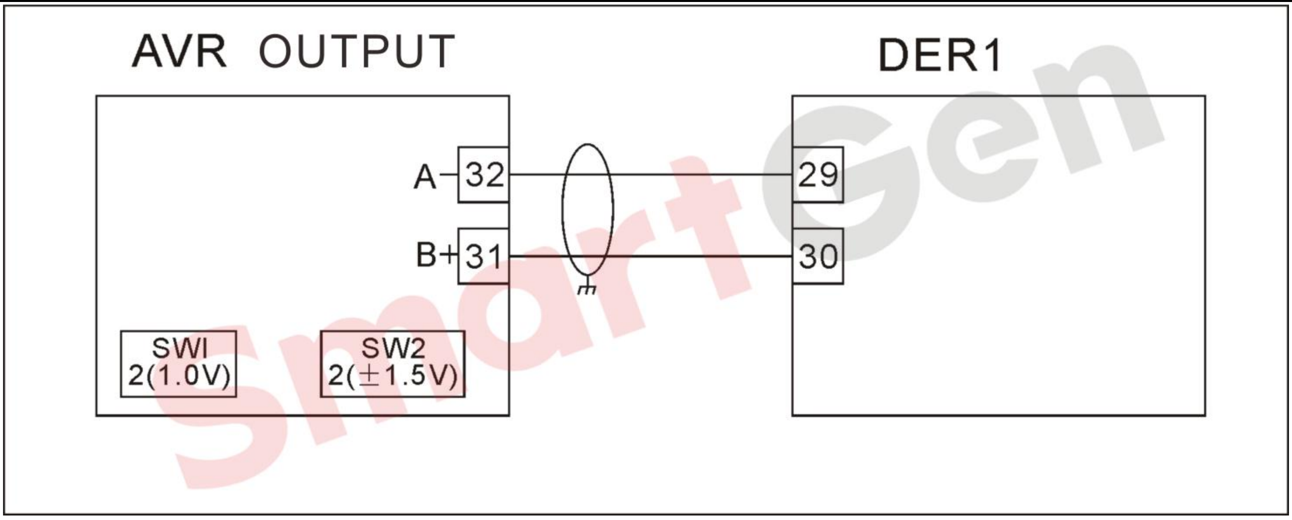


Fig. 150 MECCALTE DER1

4.3.3.5 MARELLIMOTOR

4.3.3.5.1 M16FA655A*

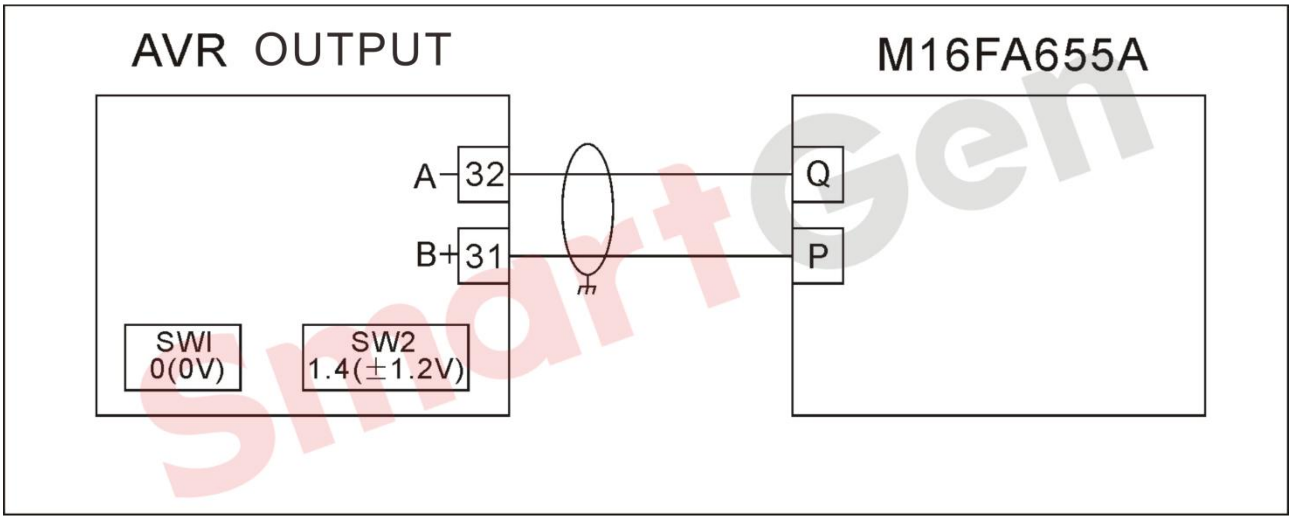


Fig. 151 MARELLIMOTOR(M16FA655A)

4.3.3.5.2 M40FA610A

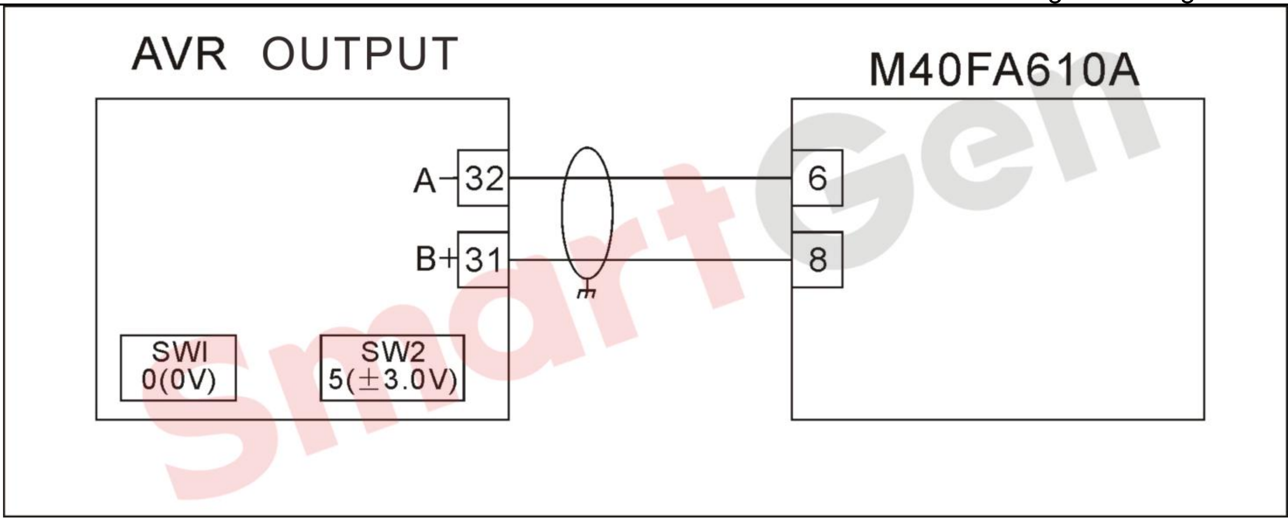


Fig. 152 MARELLIMOTOR(M40FA610A)

4.3.3.5.3 M40FA640A*

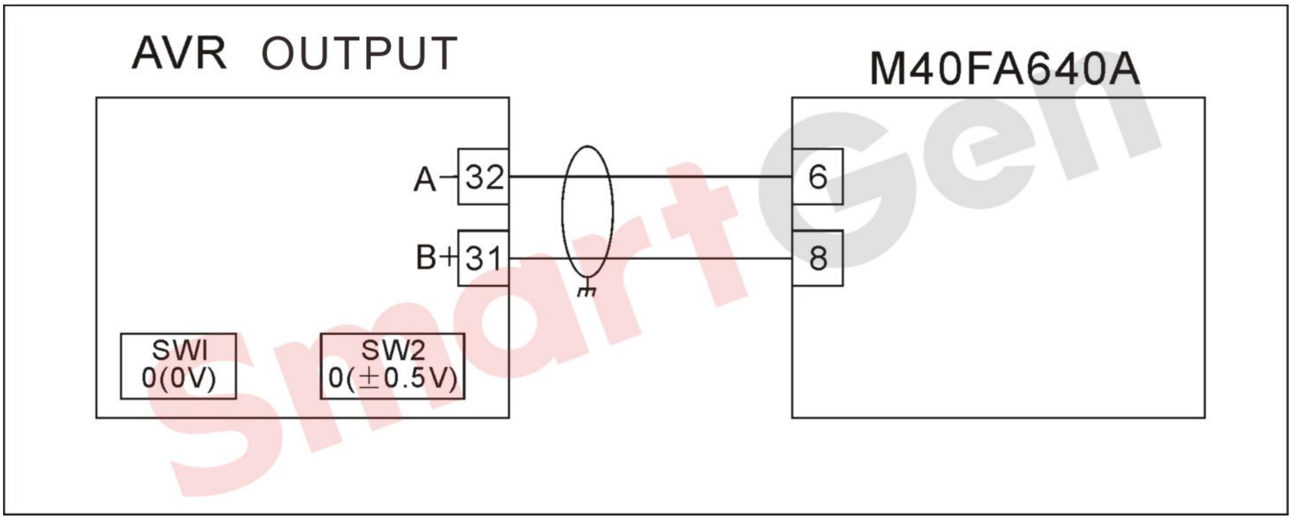


Fig. 153 MARELLIMOTOR(M40FA640A)

4.3.3.6 BASLER

4.3.3.6.1 AVC63-12

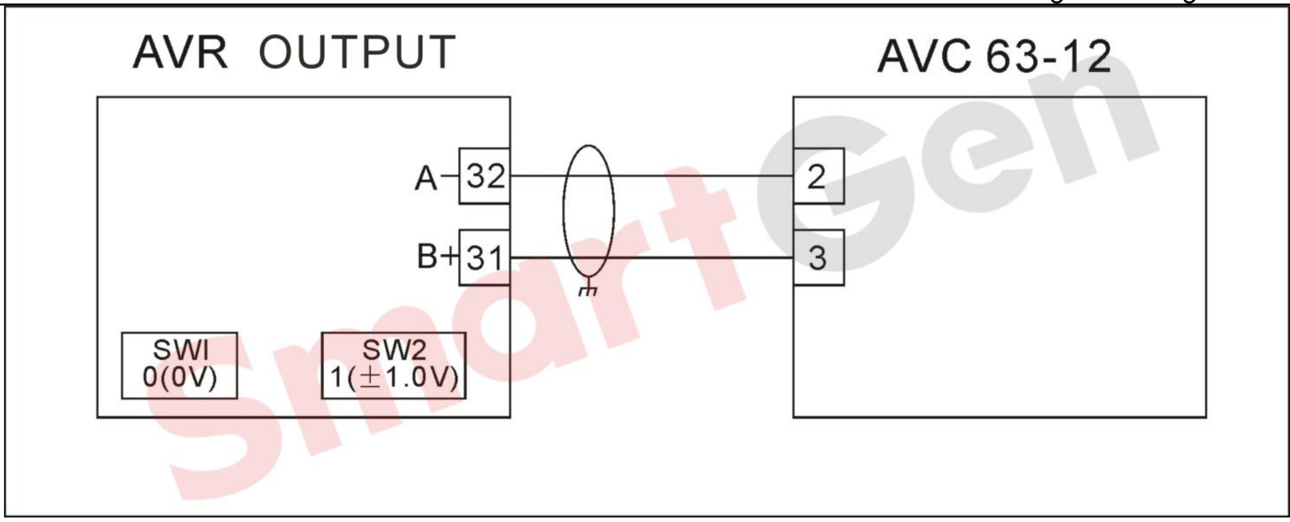


Fig. 154 BASLER(AVC63-12)

4.3.3.6.2 DECS15/DECS100

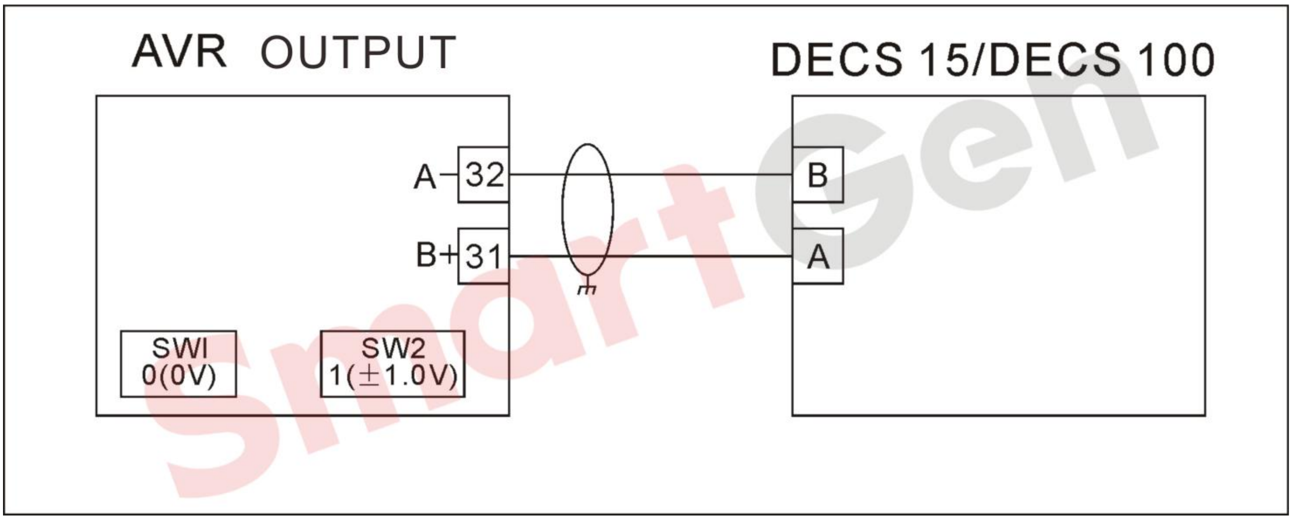


Fig. 155 BASLER(DECS15/DECS100)

4.3.3.6.3 DECS200

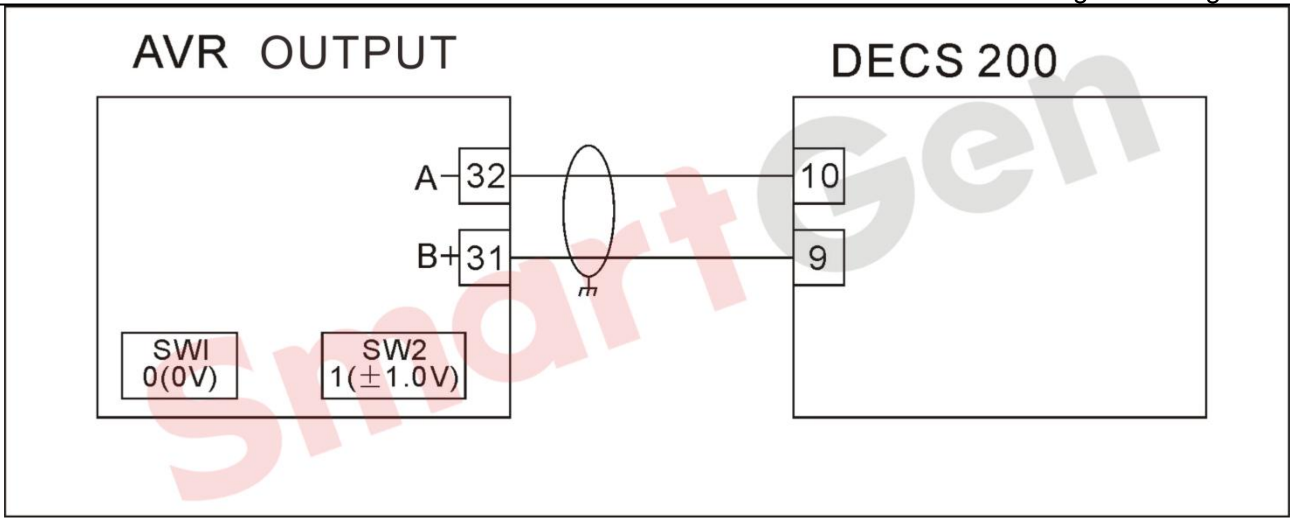


Fig. 156 BASLER(DECS200)

4.3.3.6.4 SSR

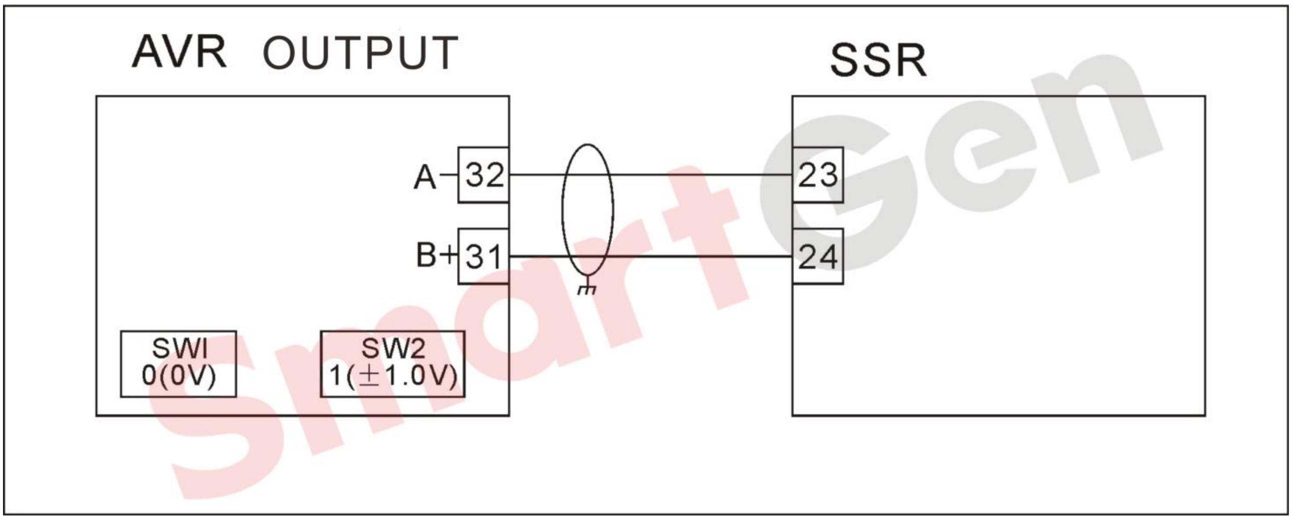


Fig. 157 BASLER(SSR)

4.3.3.7 CATERPILLAR

4.3.3.7.1 CDVR

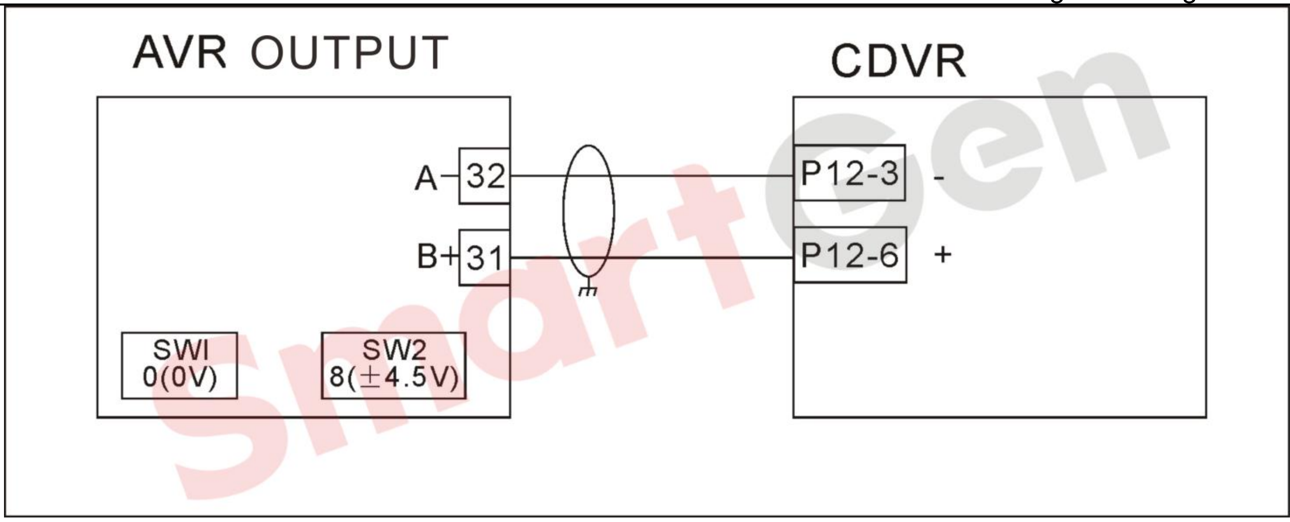


Fig. 158 CATERPILLAR CDVR

4.3.3.7.2 VR3

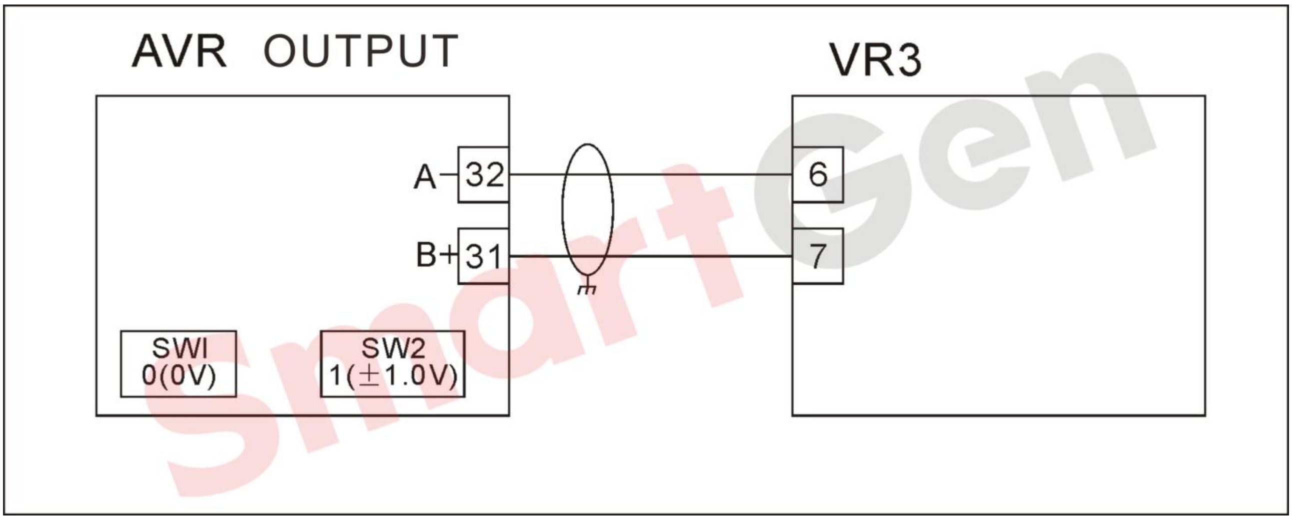


Fig. 159 CATERPILLAR VR3

4.3.3.7.3 VR6

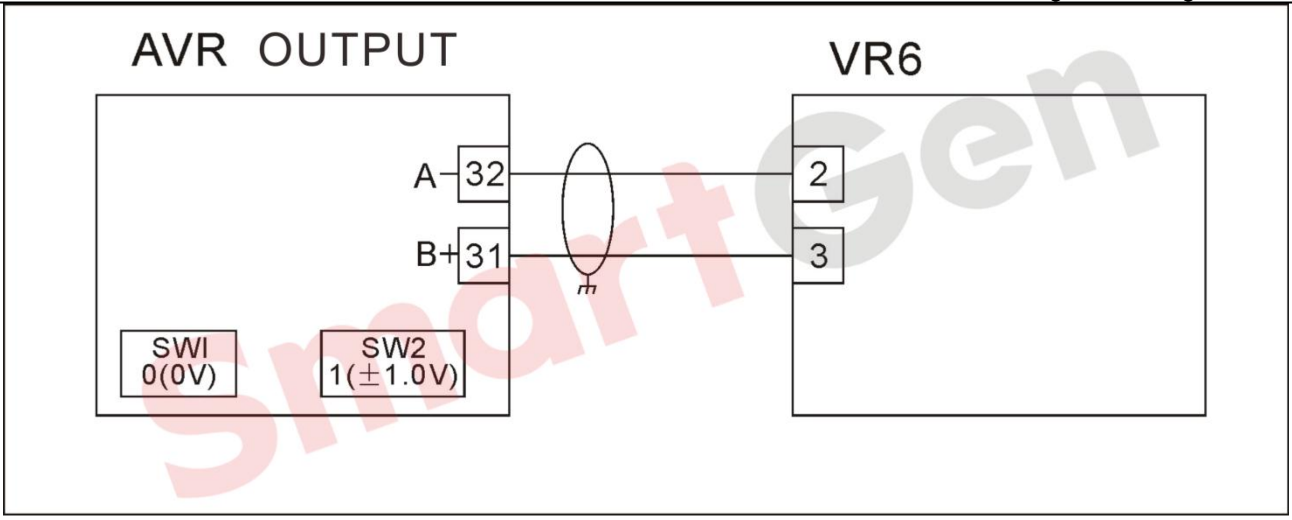


Fig. 160 CATERPILLAR VR6

4.3.3.8 COSIMAT(COSIMATN)

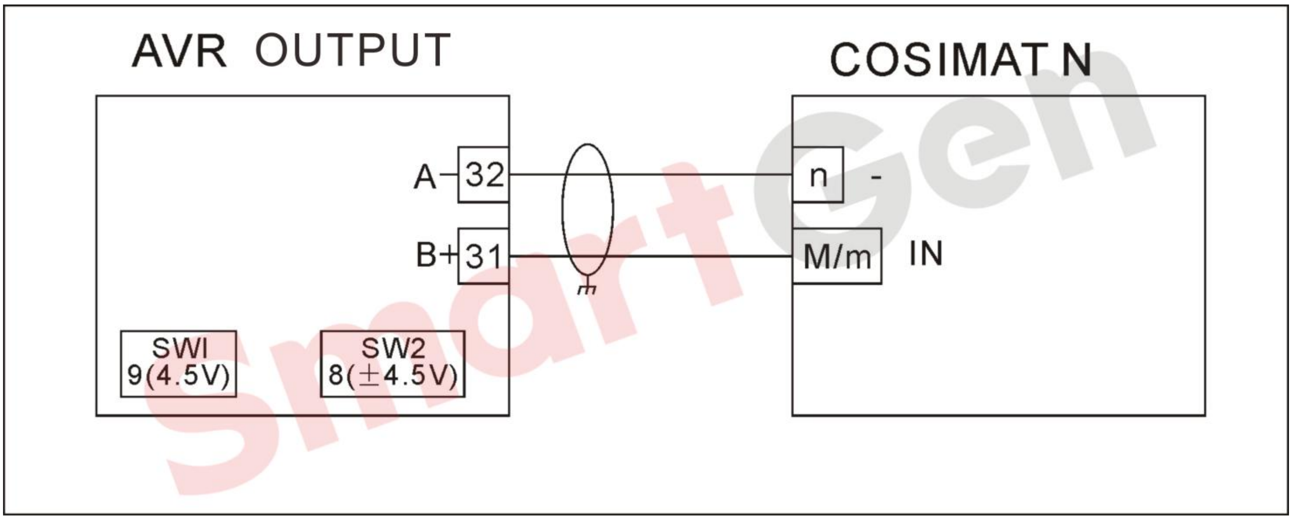


Fig. 161 COSIMAT(COSIMATN)

4.3.3.9 GRAMEYER(GRT7-TH*)

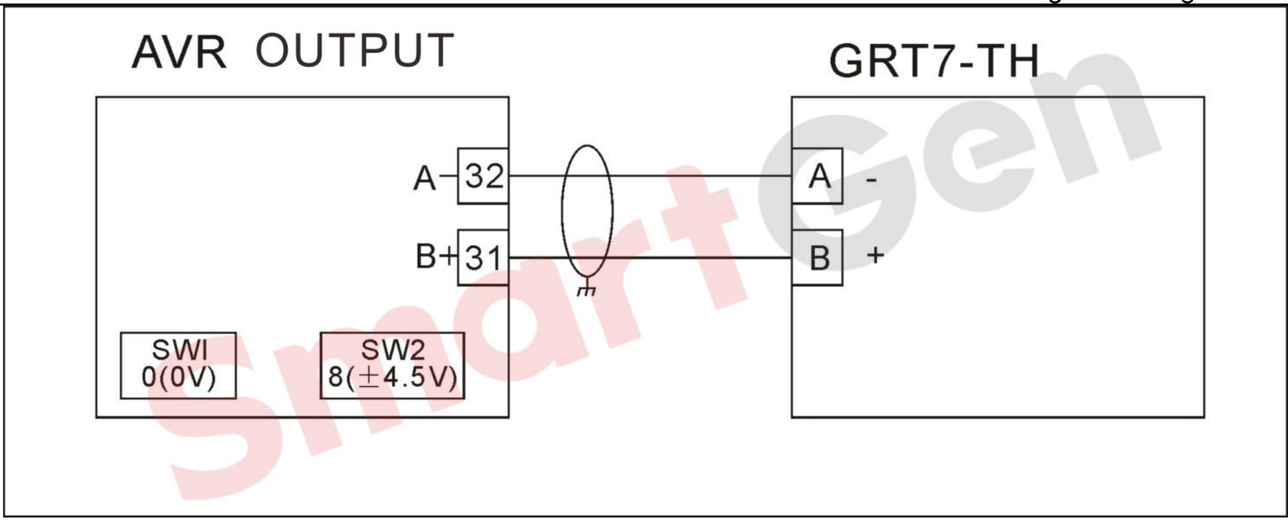


Fig. 162 GRAMEYER(GRT7-TH*)

4.3.3.10 KATO(K65-12B/K125-10B)

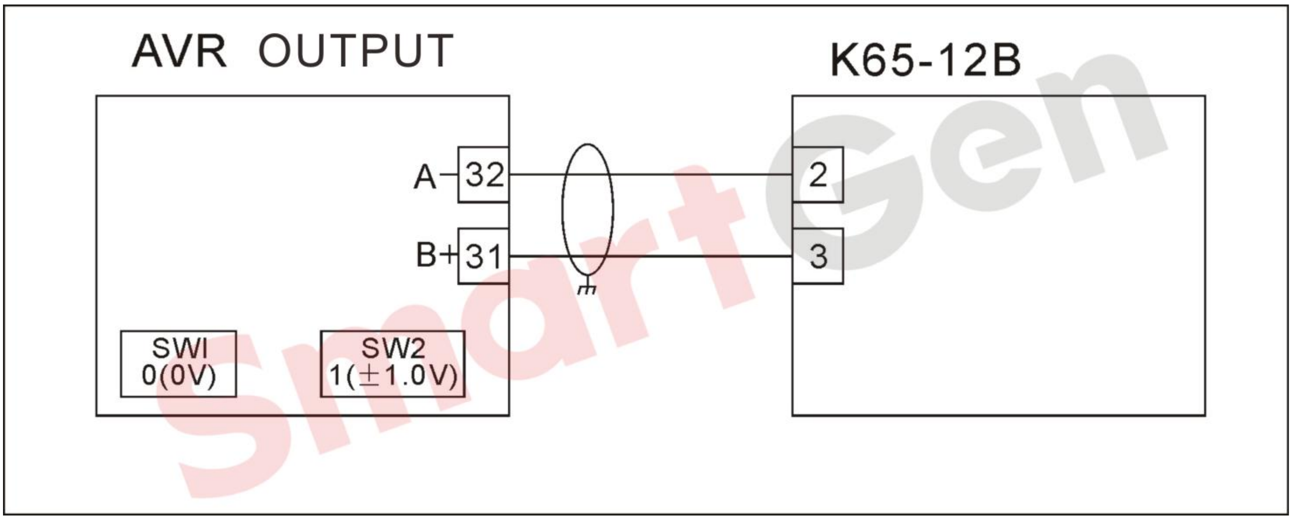


Fig. 163 KATO(K65-12B)

4.4 HGM9500N Controller GOV/AVR Parameter Setting

4.4.1 HGM9500N Controller GOV/AVR Connection Diagram

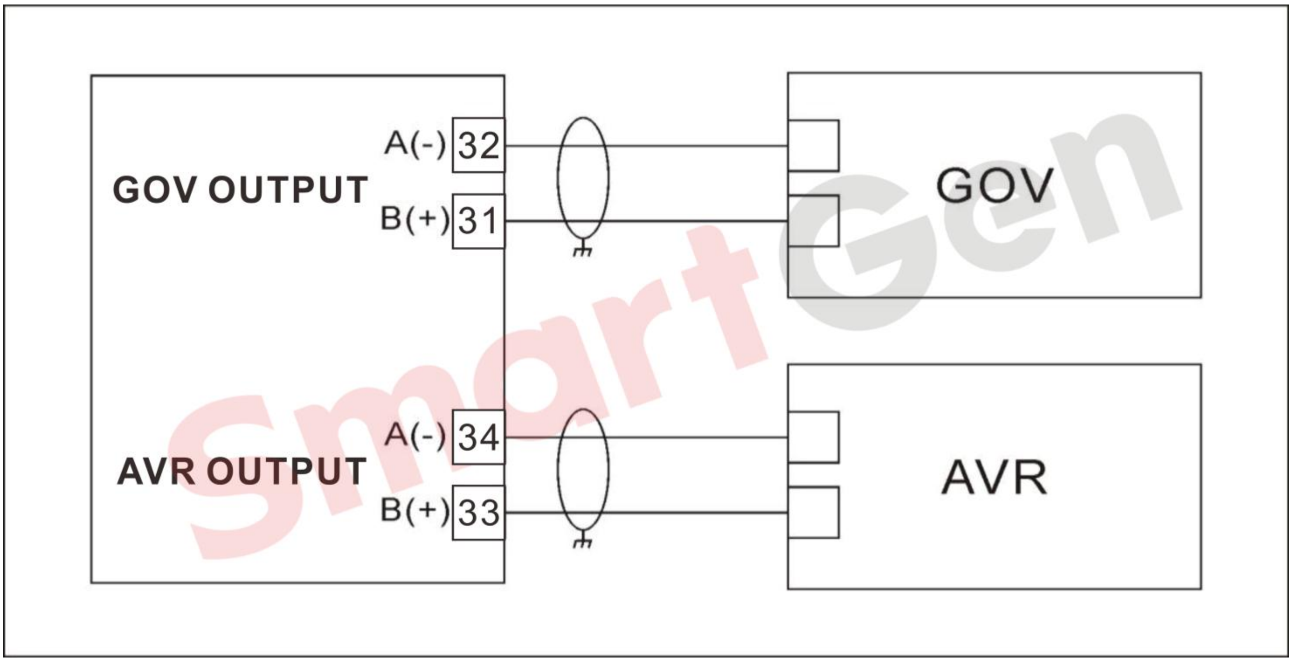


Fig. 164 HGM9500N Controller GOV/AVR Connection Diagram

4.4.2 GOV Wiring

4.4.2.1 GAC Governor(5100-5500 Series)

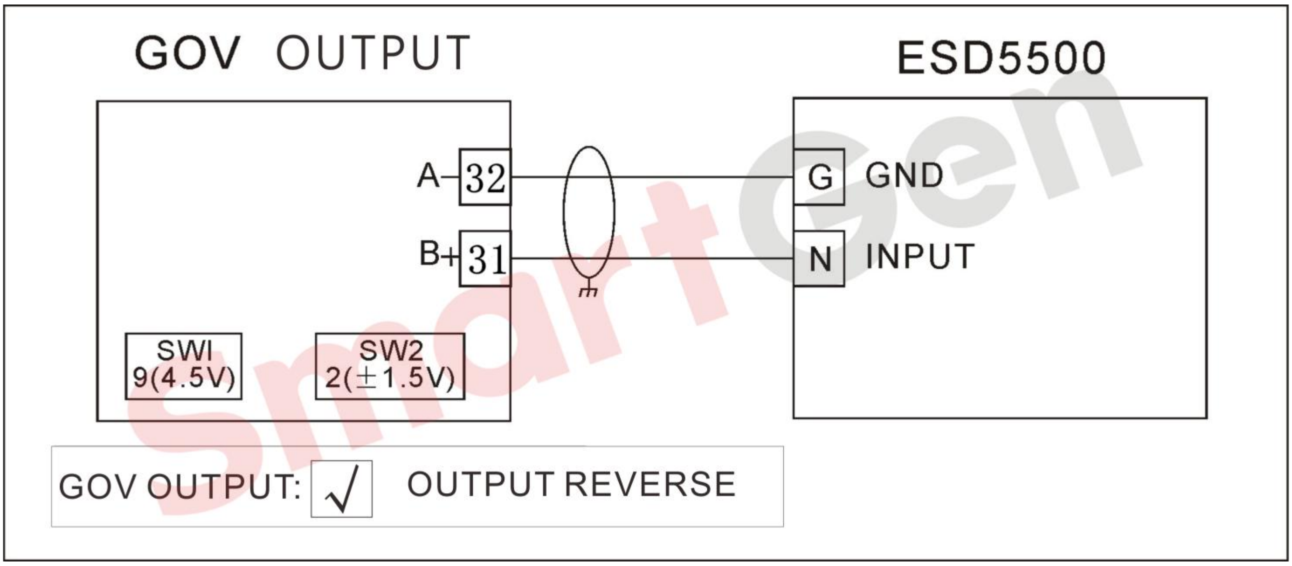


Fig. 165 GAC(5100-5500)

4.4.2.2 CUMMINS

4.4.2.2.1 EFC* Series

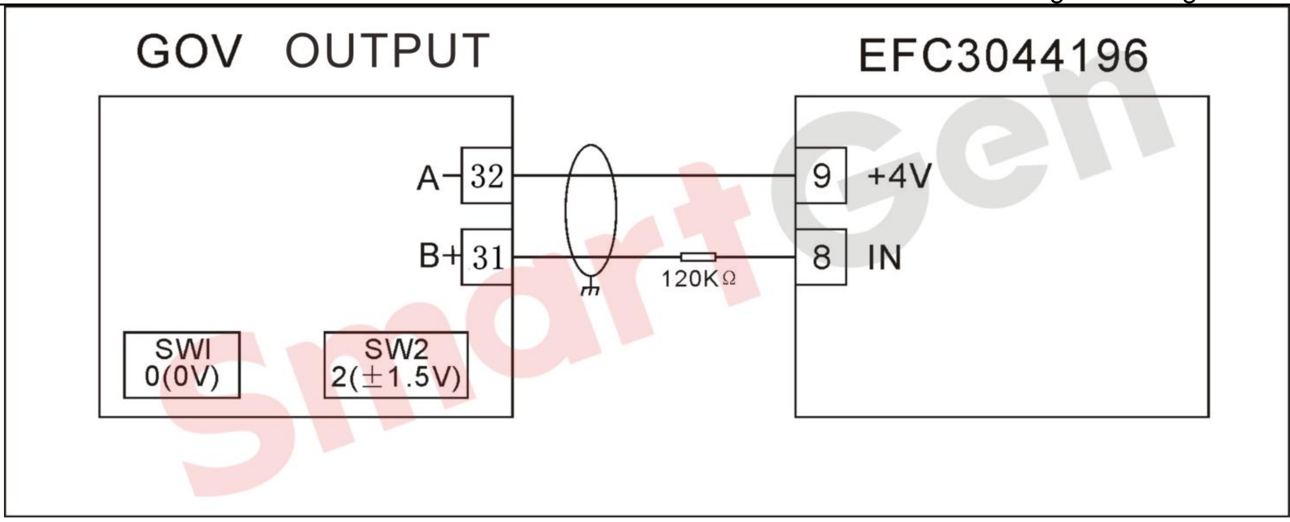


Fig. 166 CUMMINS EFC* Series

4.4.2.2.2 EFCILS

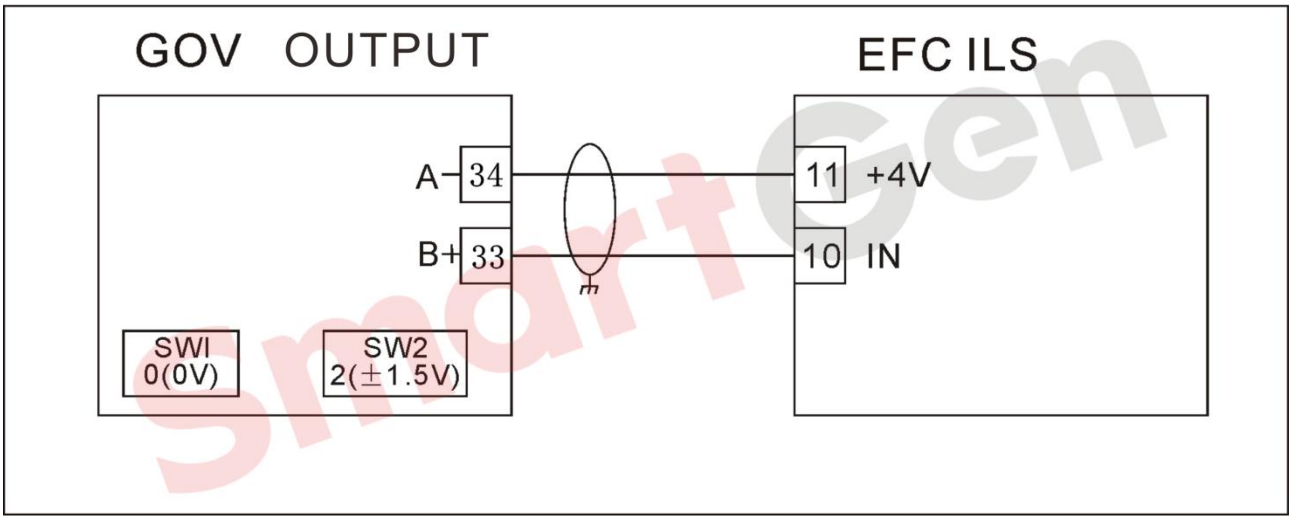


Fig. 167 CUMMINS EFCILS

4.4.2.3 VOLVO

4.4.2.3.1 EMS2

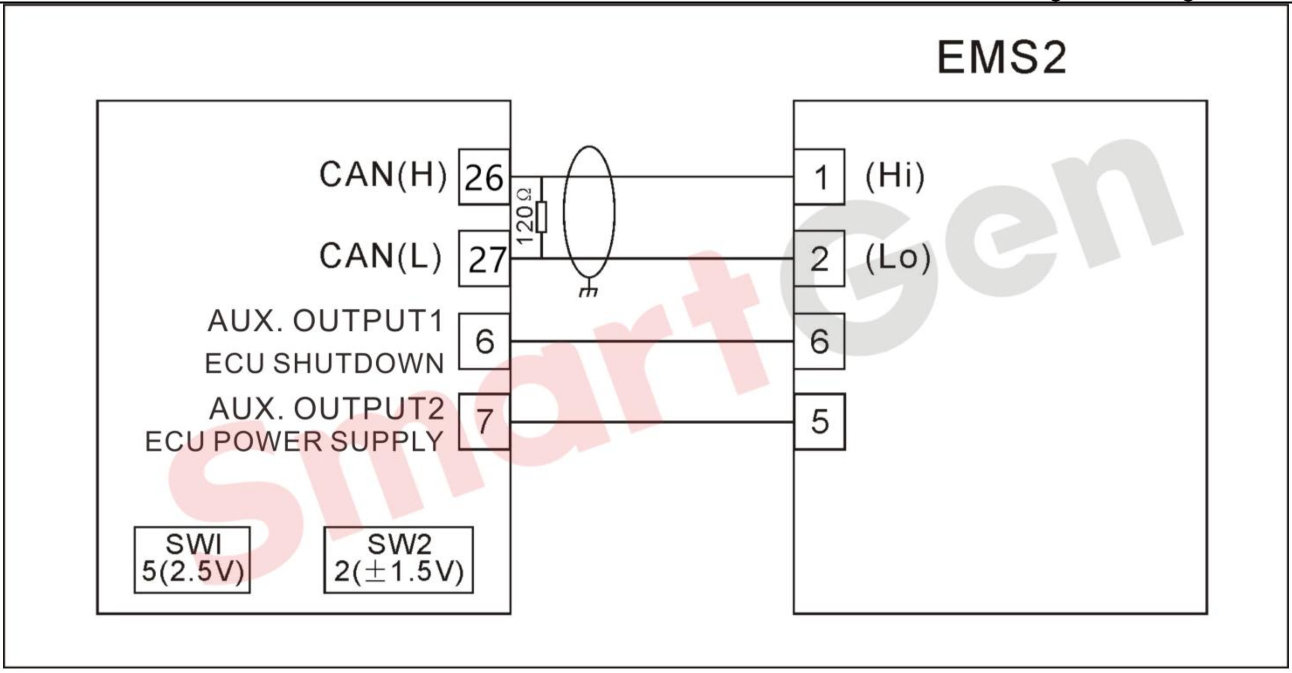


Fig. 168 VOLVO EMS2

4.4.2.3.2 EDC3

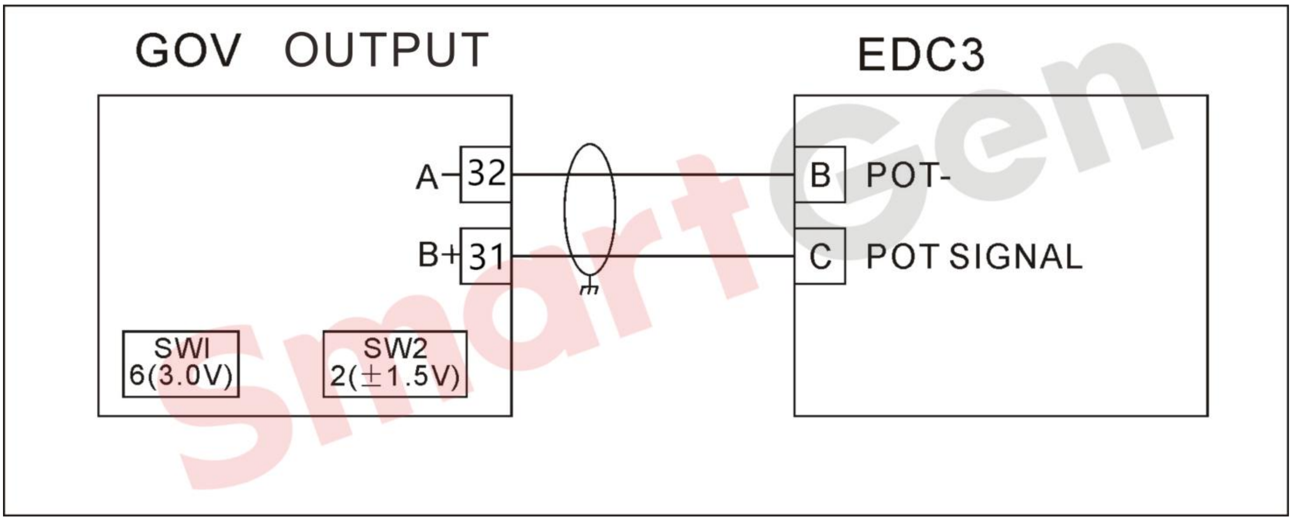


Fig. 169 VOLVO EDC3

4.4.2.4 PERKINS

4.4.2.4.1 2000 Series Engine

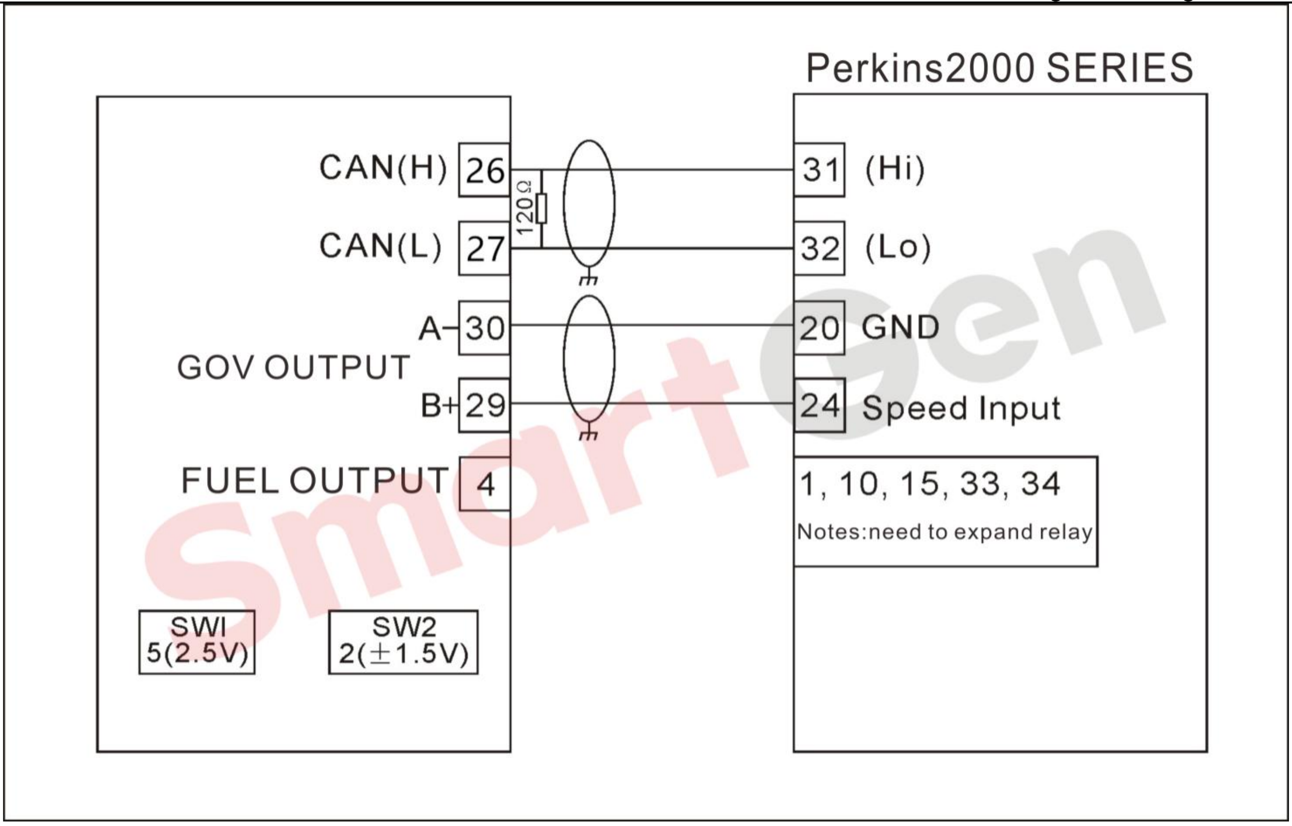


Fig. 170 PERKINS 2000 Series

4.4.2.4.2 1300 Series Engine

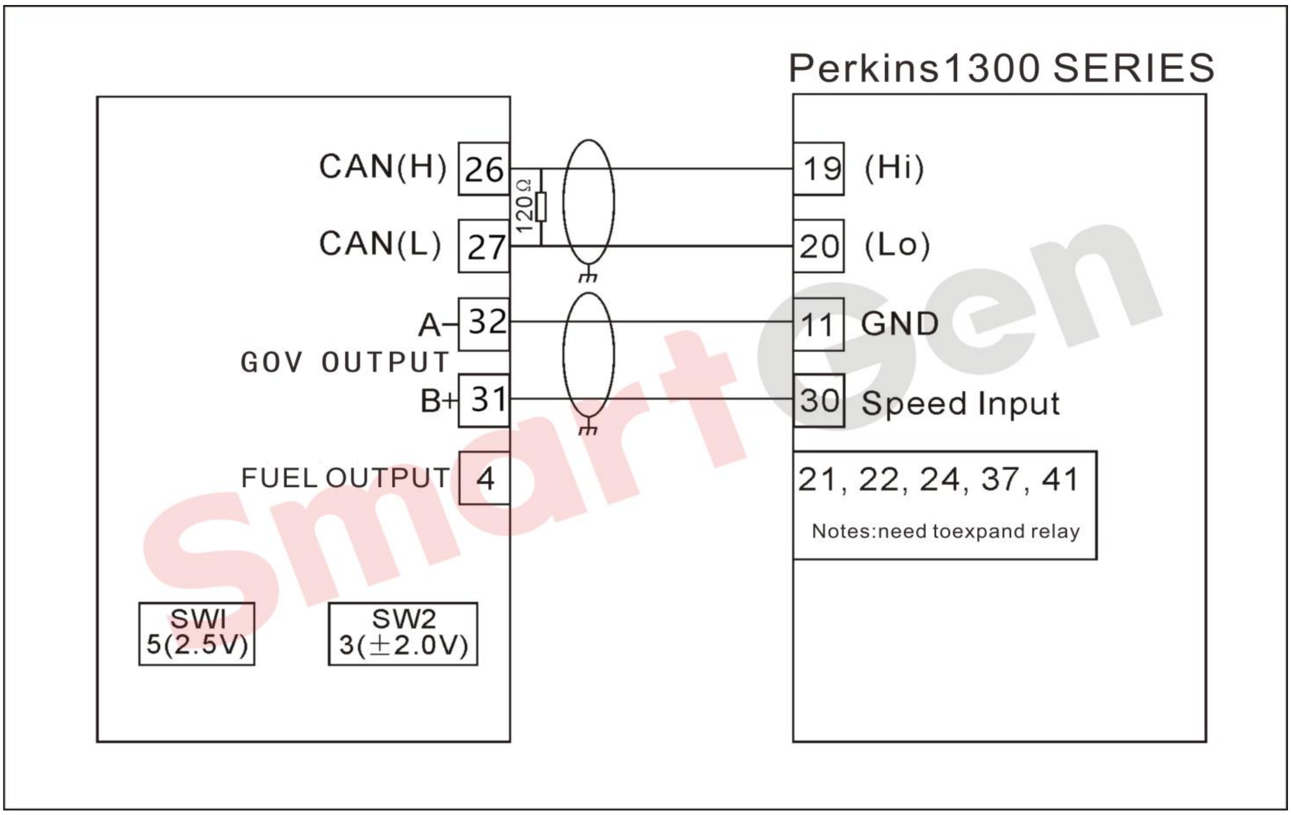


Fig. 171 PERKINS1300 Series

4.4.2.5 AMBAC

4.4.2.5.1 EC5000*/EC5100*/EC5110*

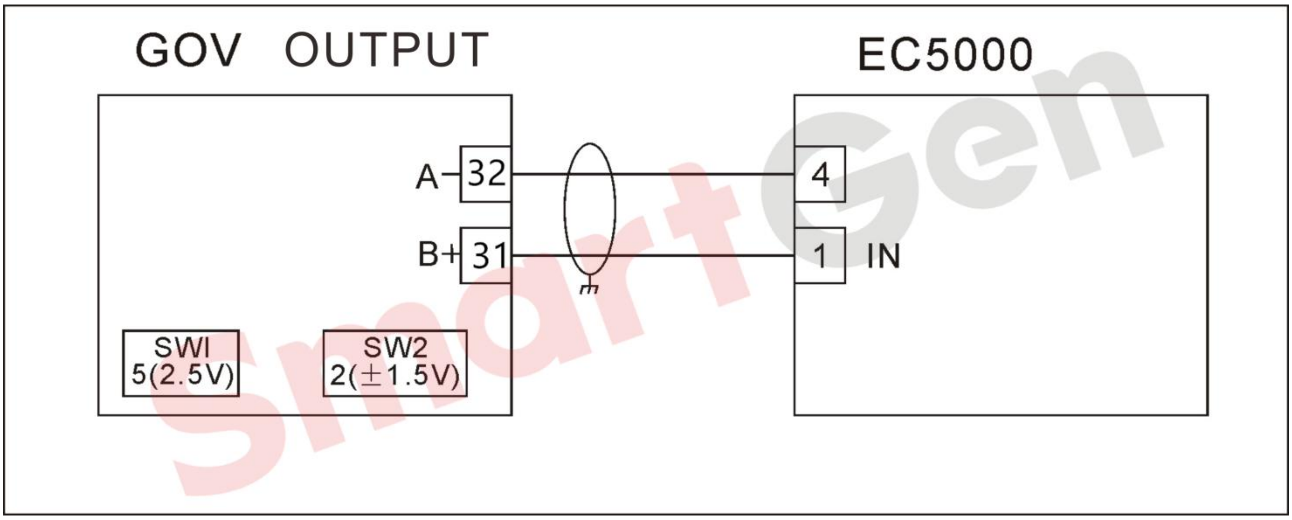


Fig. 172 AMBAC(EC5000)

4.4.2.5.2 CW673C

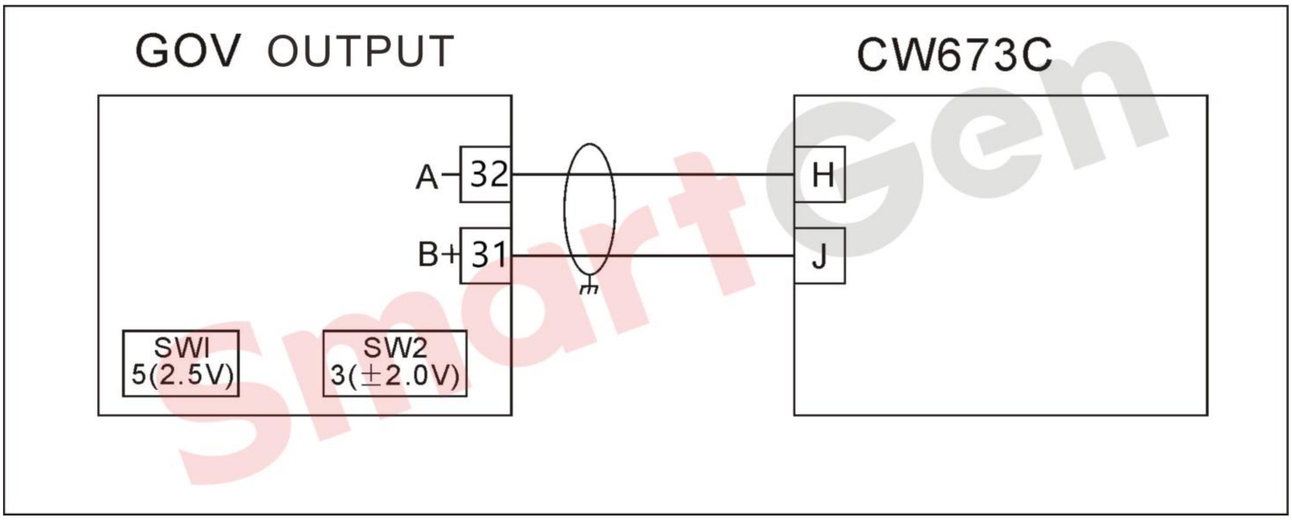


Fig. 173 AMBAC(CW673C)

4.4.2.6 BARBERCOLMAN

4.4.2.6.1 DYN110502/10503/10504/10506

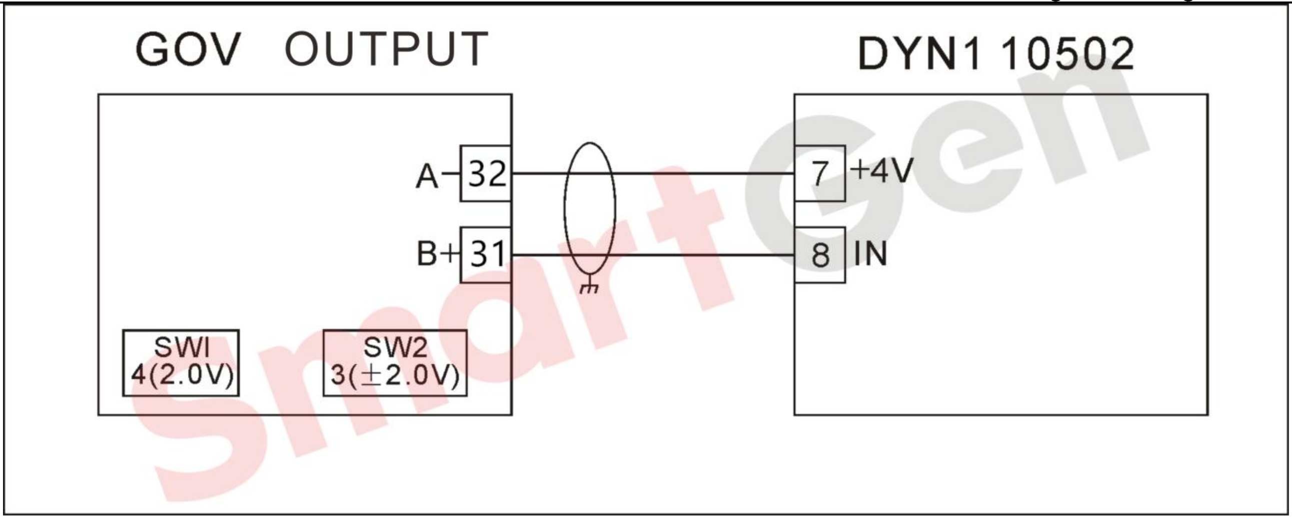


Fig. 174 BARBERCOLMAN(DYN110502)

4.4.2.6.2 DYN110693/10694/10695/10752/10753/10754/10756

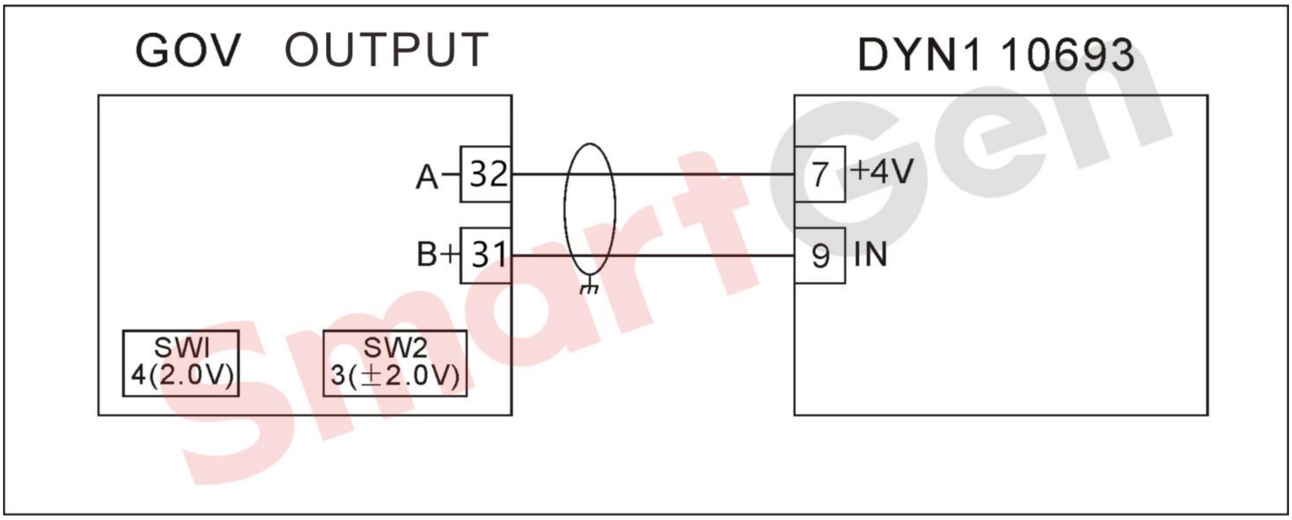


Fig. 175 BARBERCOLMAN(DYN110693)

4.4.2.6.3 DYN110794*

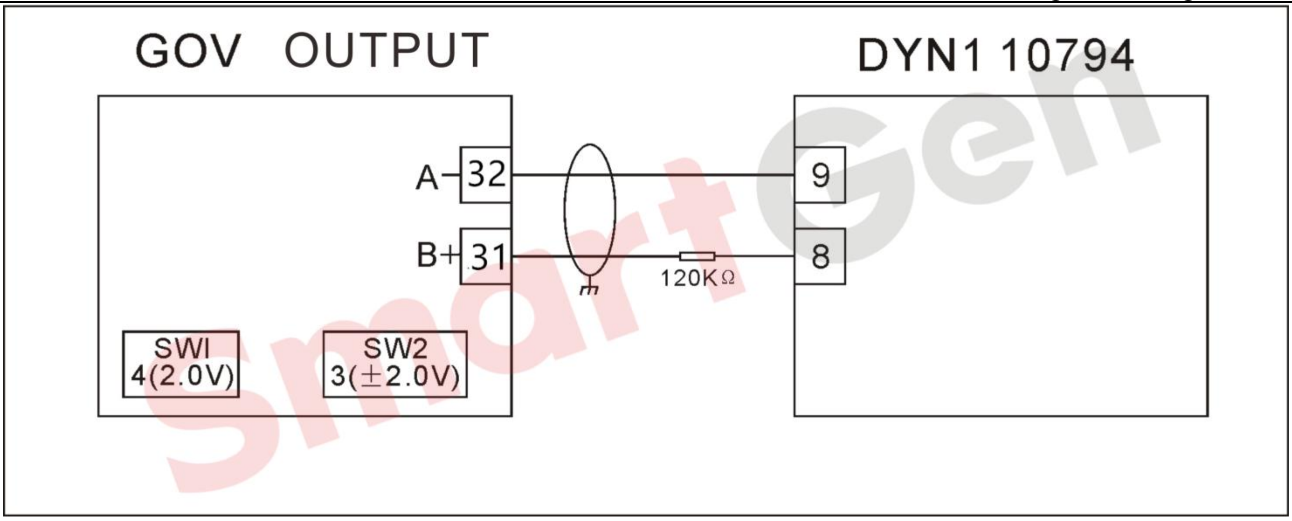


Fig. 176 BARBERCOLMAN(DYN110794)

4.4.2.6.4 DYN110871

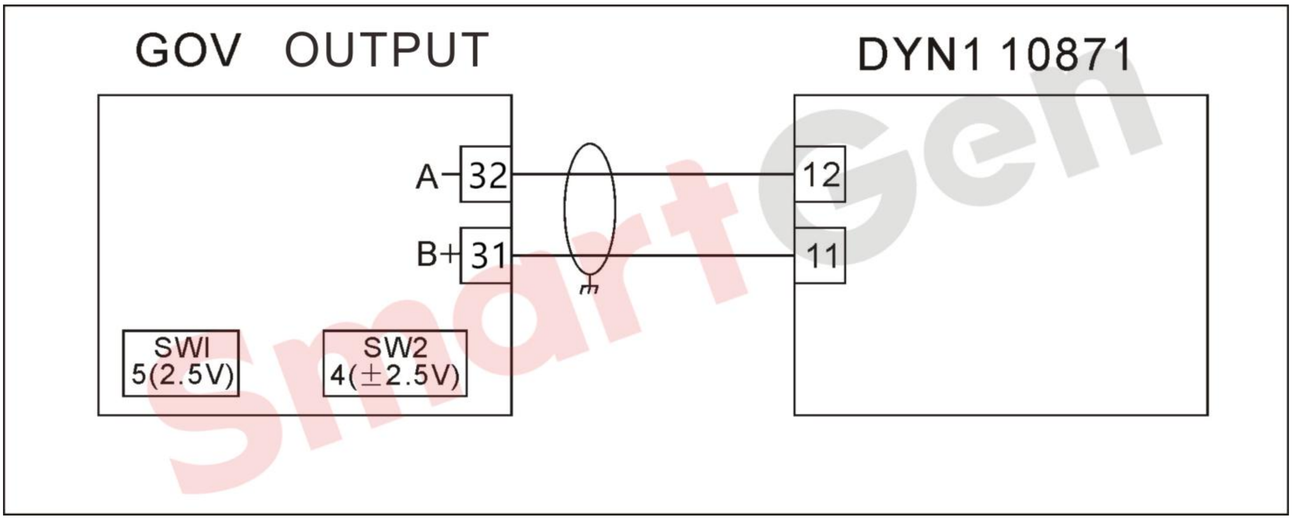


Fig. 177 BARBERCOLMAN(DYN110871)

4.4.2.6.5 DPG2201*

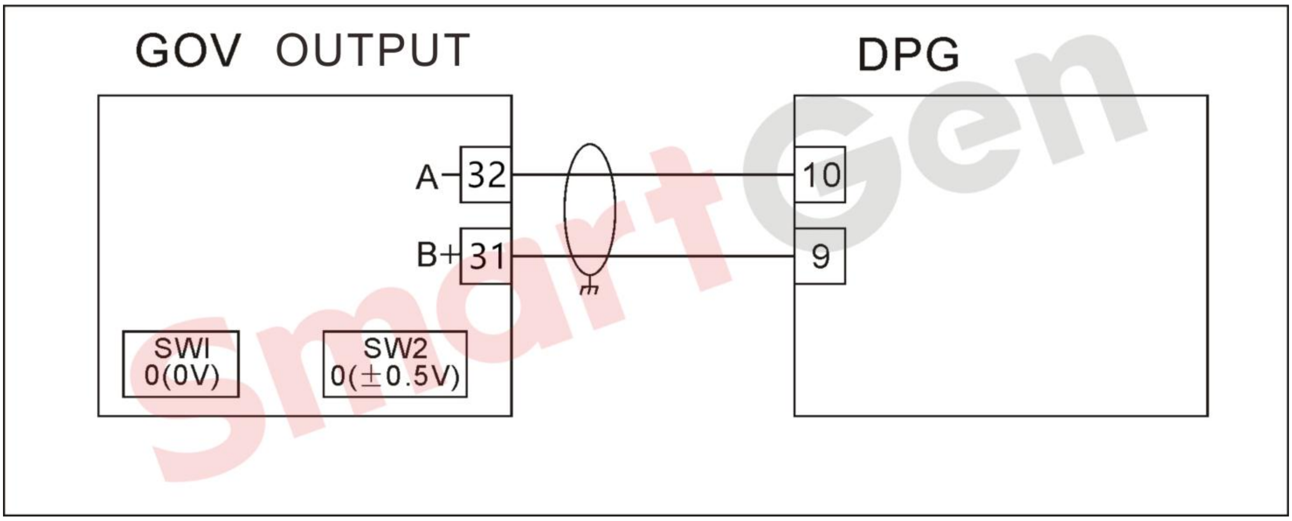


Fig. 178 BARBERCOLMAN(DPG2201*)

4.4.2.6.6 DPG2401

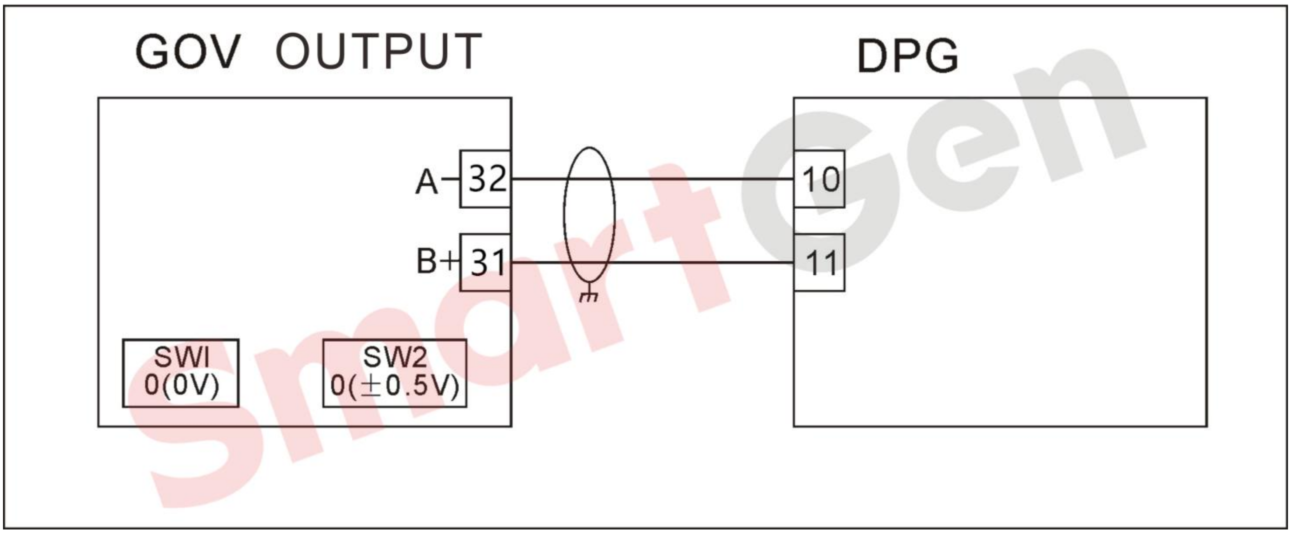


Fig. 179 BARBERCOLMAN(DPG2401)

4.4.2.6.7 DYNA8000*

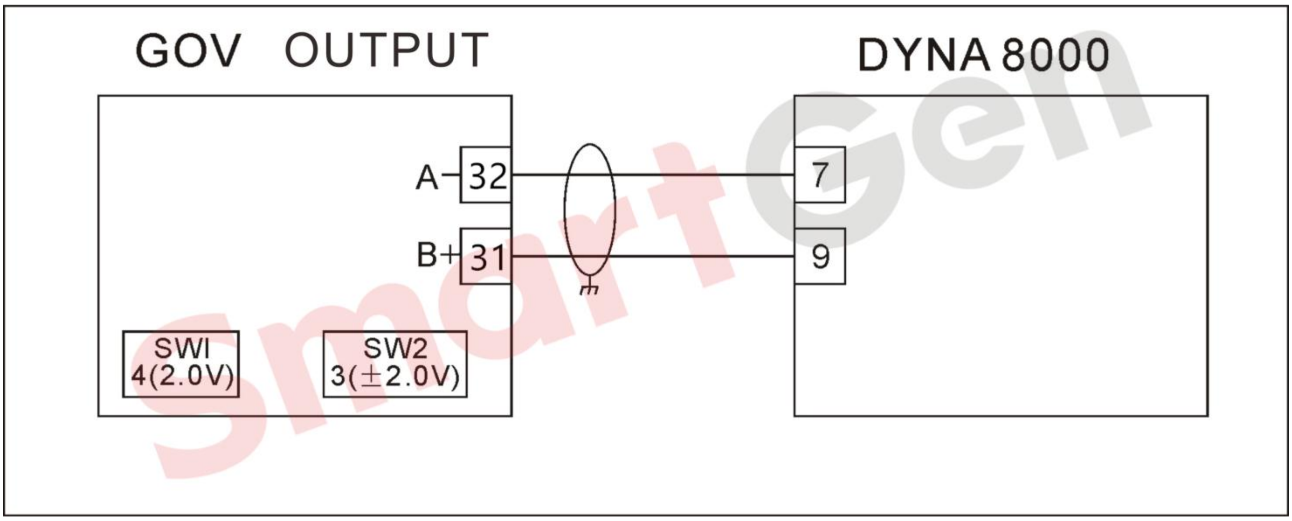


Fig. 180 BARBERCOLMAN(DYNA8000*)

4.4.2.7 CATERPILLAR ADEM*

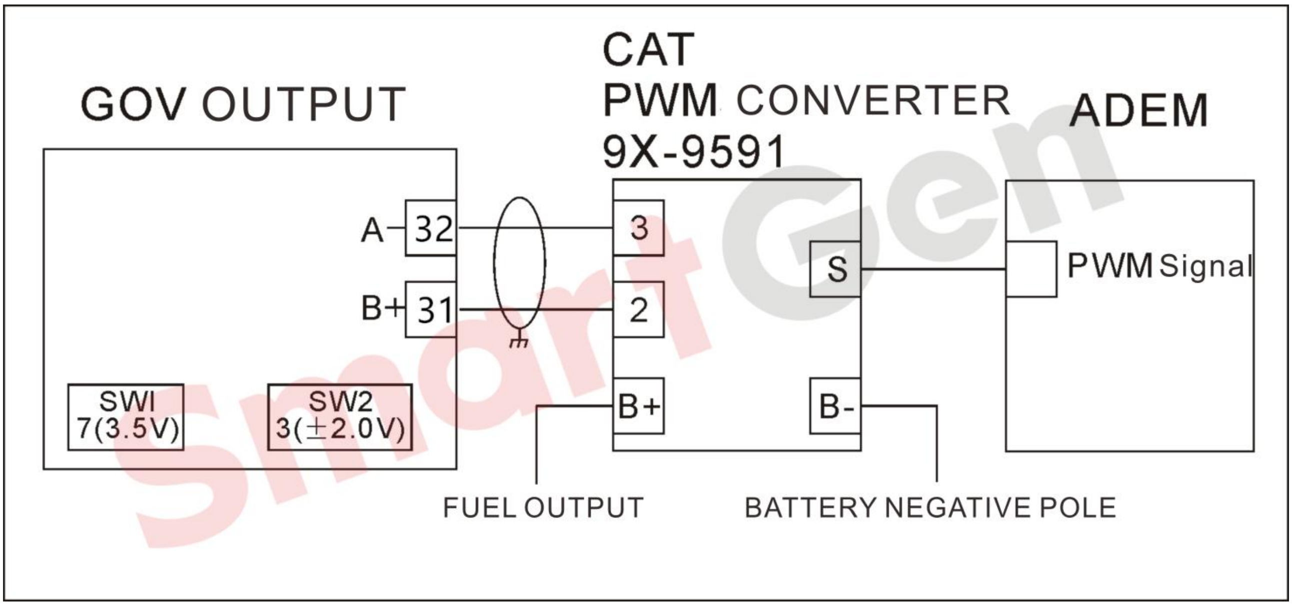


Fig. 181 CATERPILLAR ADEM

4.4.2.8 DETROIT

4.4.2.8.1 DDECIII

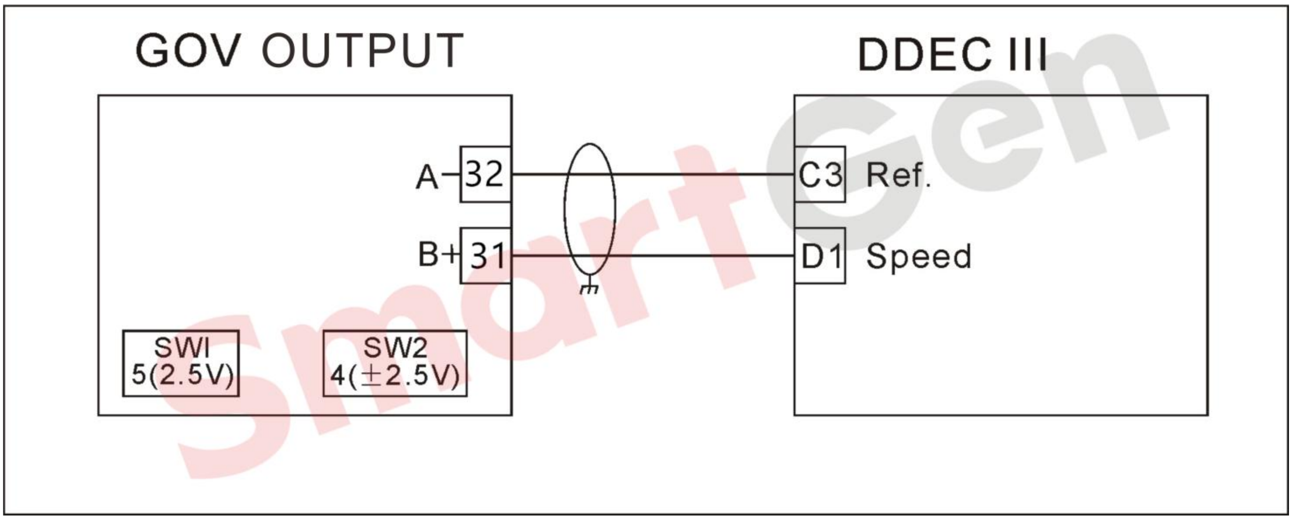


Fig. 182 DDECIII

4.4.2.8.2 DDECIV*

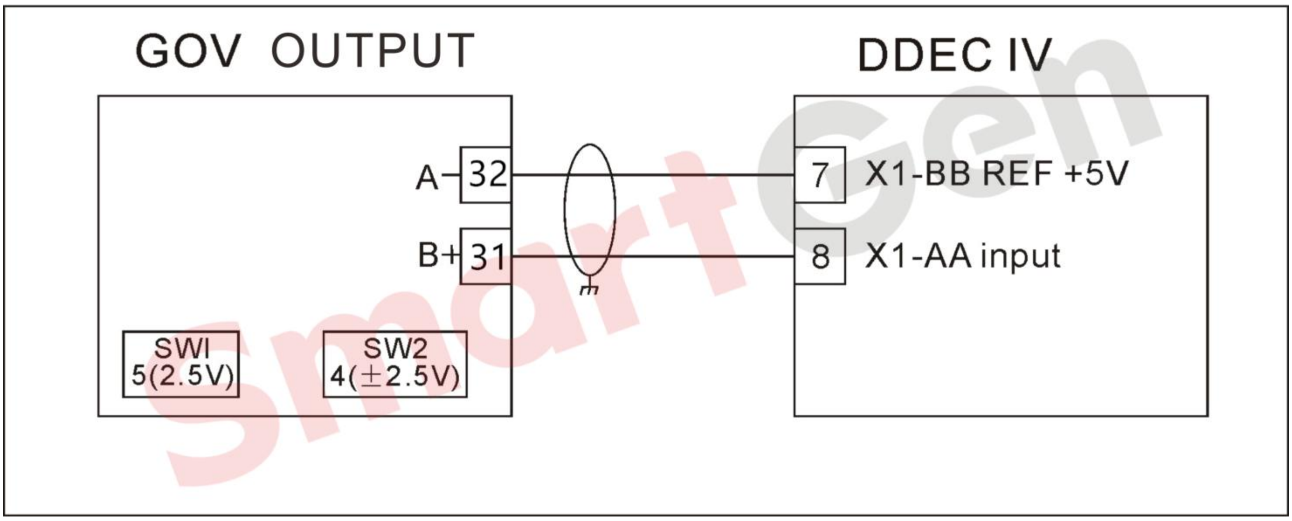


Fig. 183 CATERPILLAR DDECIV

4.4.2.9 DEUTZ

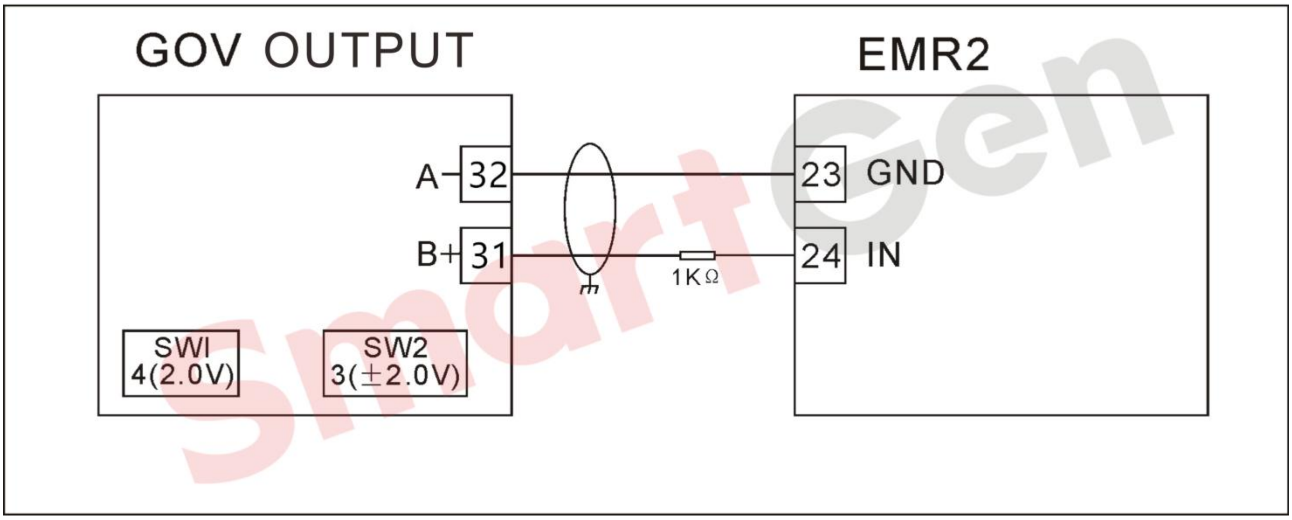


Fig. 184 DEUTZ EMR2

4.4.2.10 DOOSAN

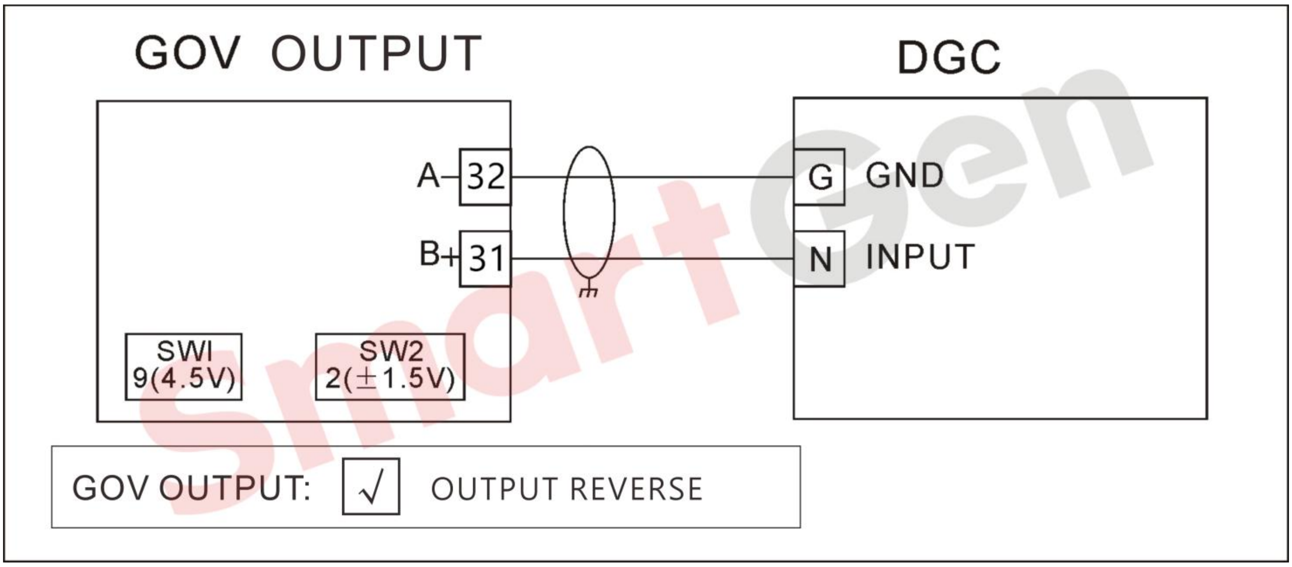


Fig. 185 DOOSAN DGC

4.4.2.11 GHANACONTROL(DGC-2007*)

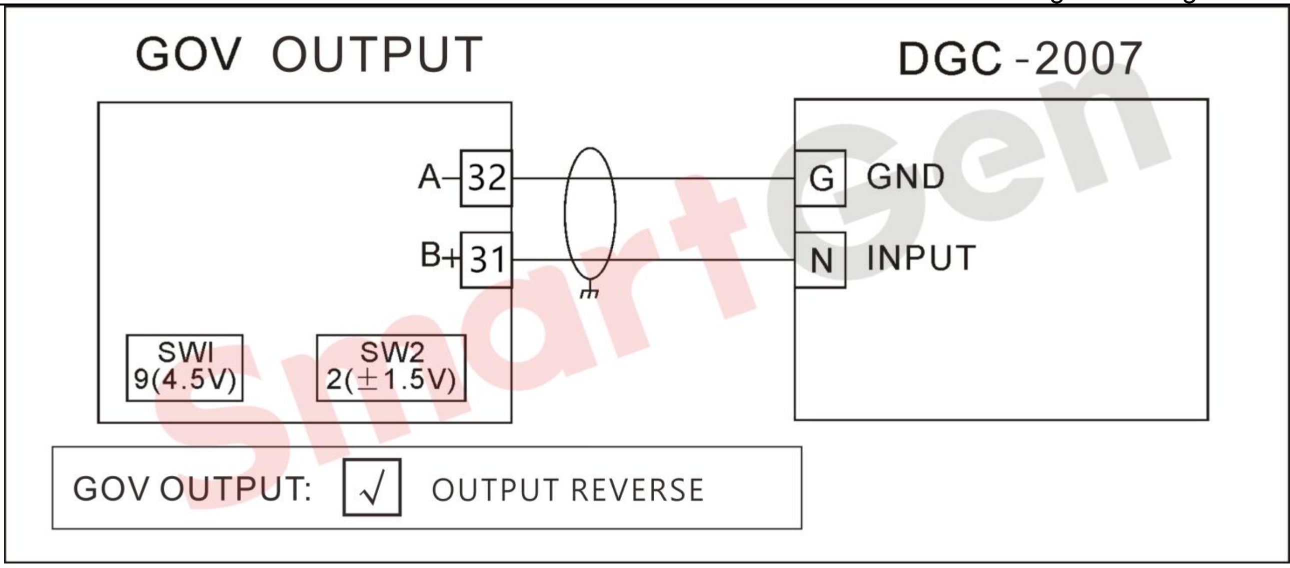


Fig. 186 GHANACONTROL(DGC-2007*)

4.4.2.12 HEINZMANN

4.4.2.12.1 KG Series

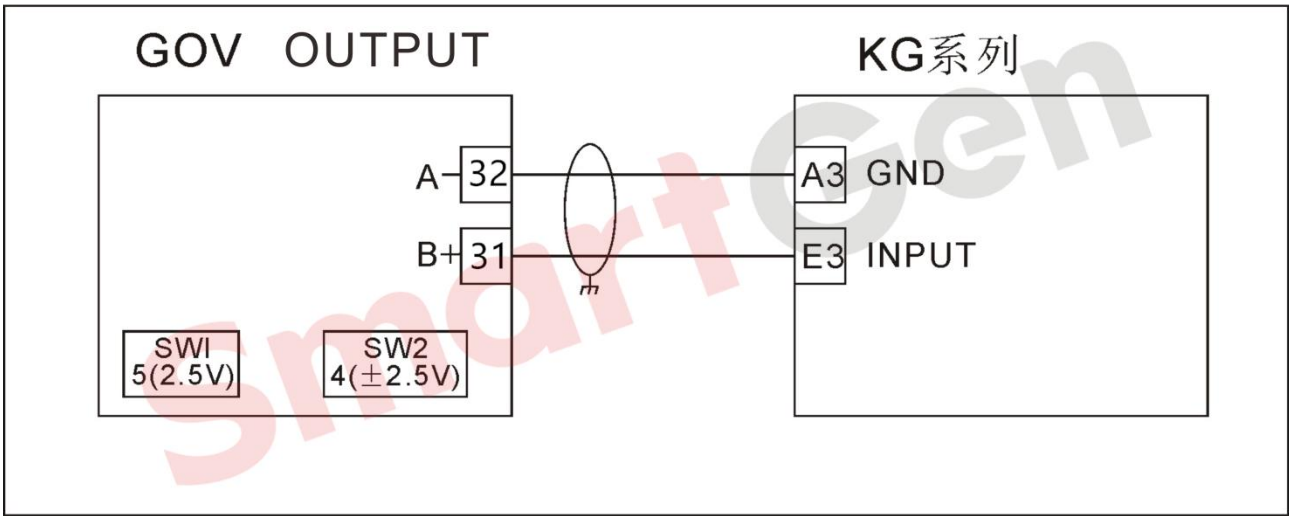


Fig. 187 HEINZMANN KG Series

4.4.2.12.2 PANDAROS*

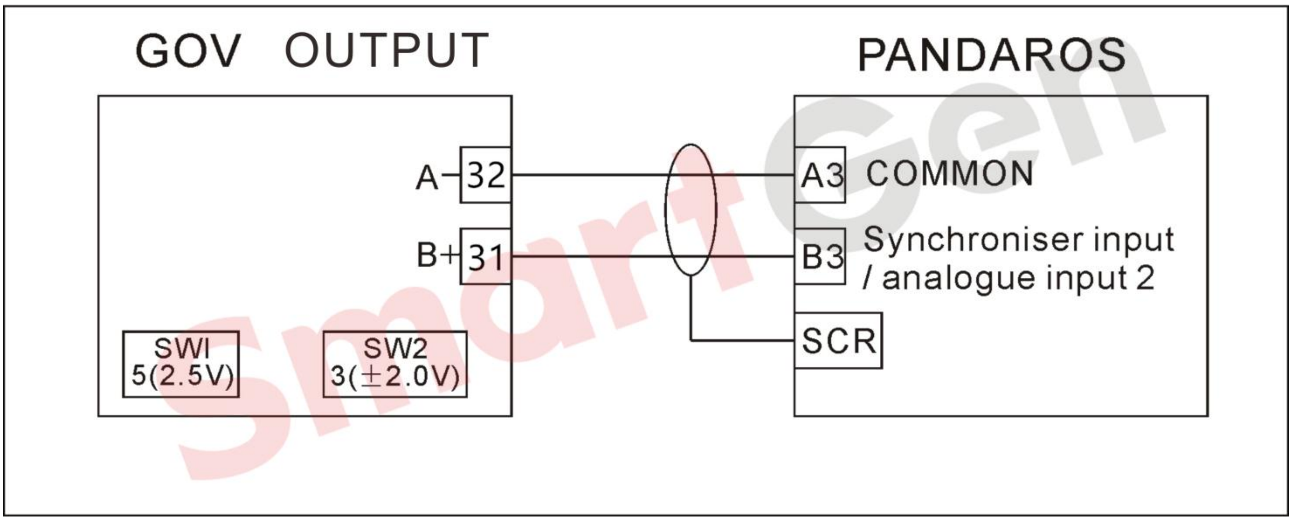


Fig. 188 HEINZMANN (PANDAROS*)

Note: Pandaros needs to use "PandarosPackager" software for the following configuration:

——Single unit/Parallel without sagging.

——Analog input 1 (Load sharing) is disenabled.

——Analog input 2 (Synchronous input) is configured as 0-5V input.

4.4.2.13 IVECO CURSOR13TE2(WITHSCIBOX)*

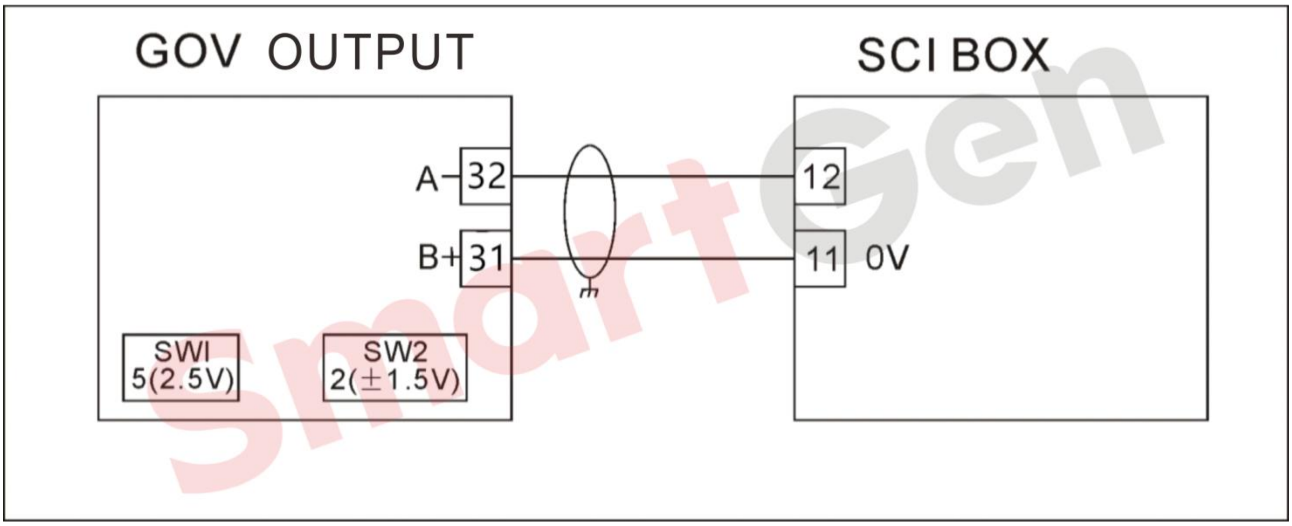


Fig. 189 IVECO (SCIBOX)

Note: The dial switches in SCI box are set as follows: 1=OFF，2=ON，3=OFF，4=OFF

4.4.2.14 JOHNDEERE

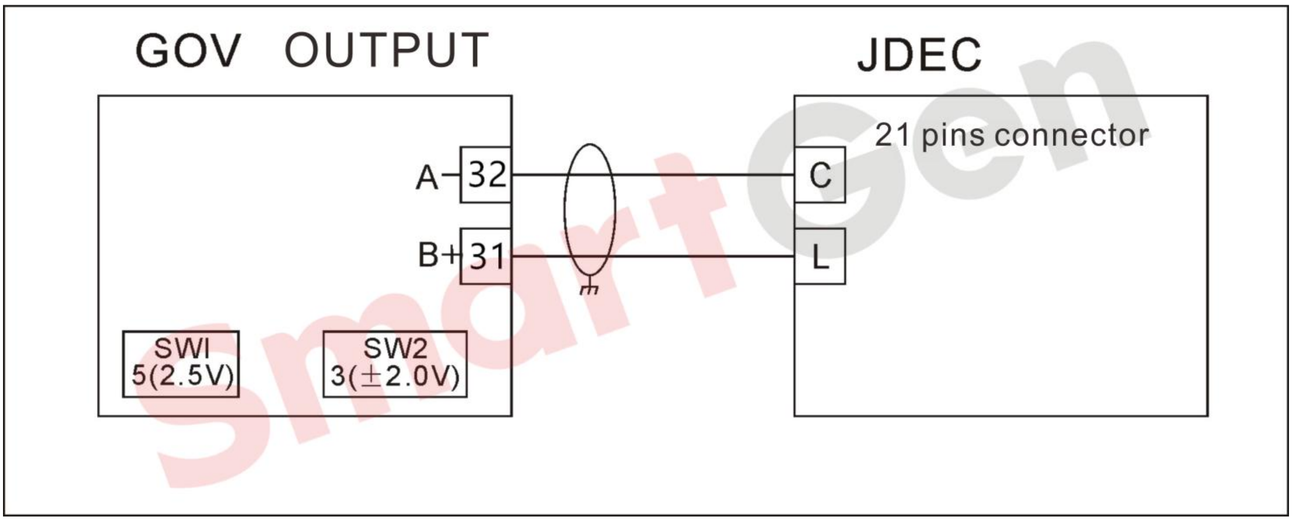


Fig. 190 JOHNDEERE JDEC

4.4.2.15 MITSUBISHI

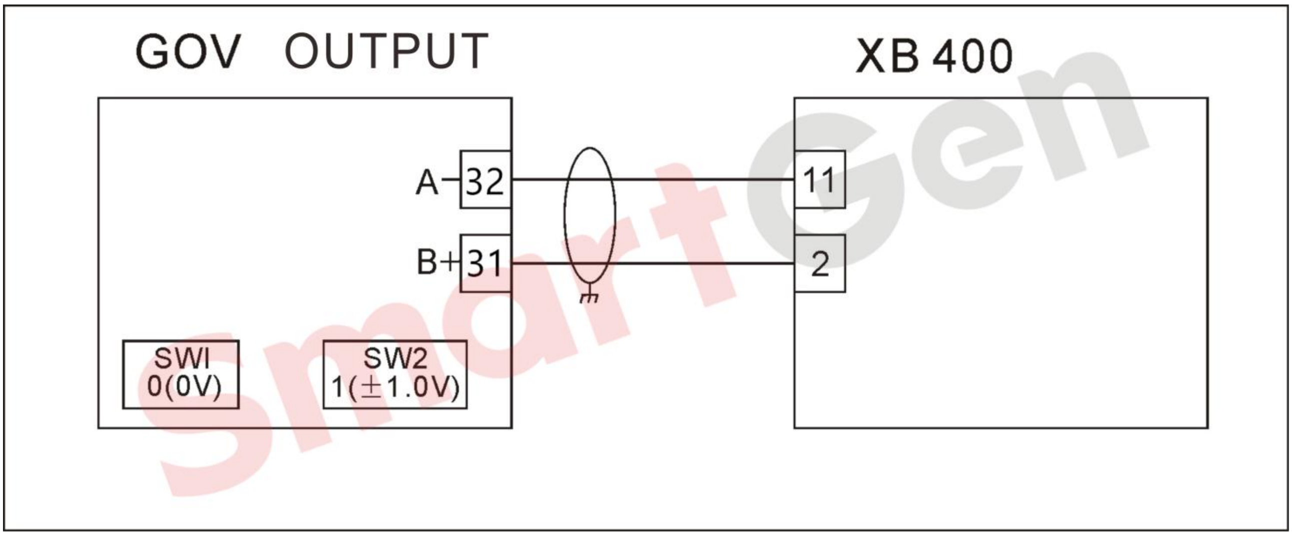


Fig. 191 (MITSUBISHI XB400*)

4.4.2.16 MTU

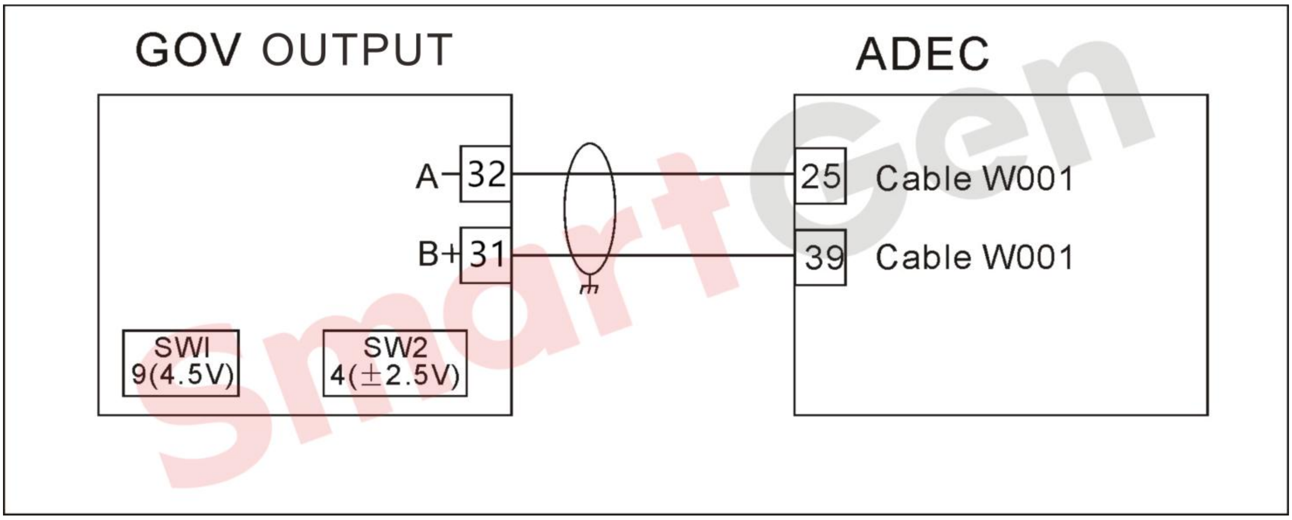


Fig. 192 MTU(ADEC2000*/4000)

4.4.2.17 SCANIA

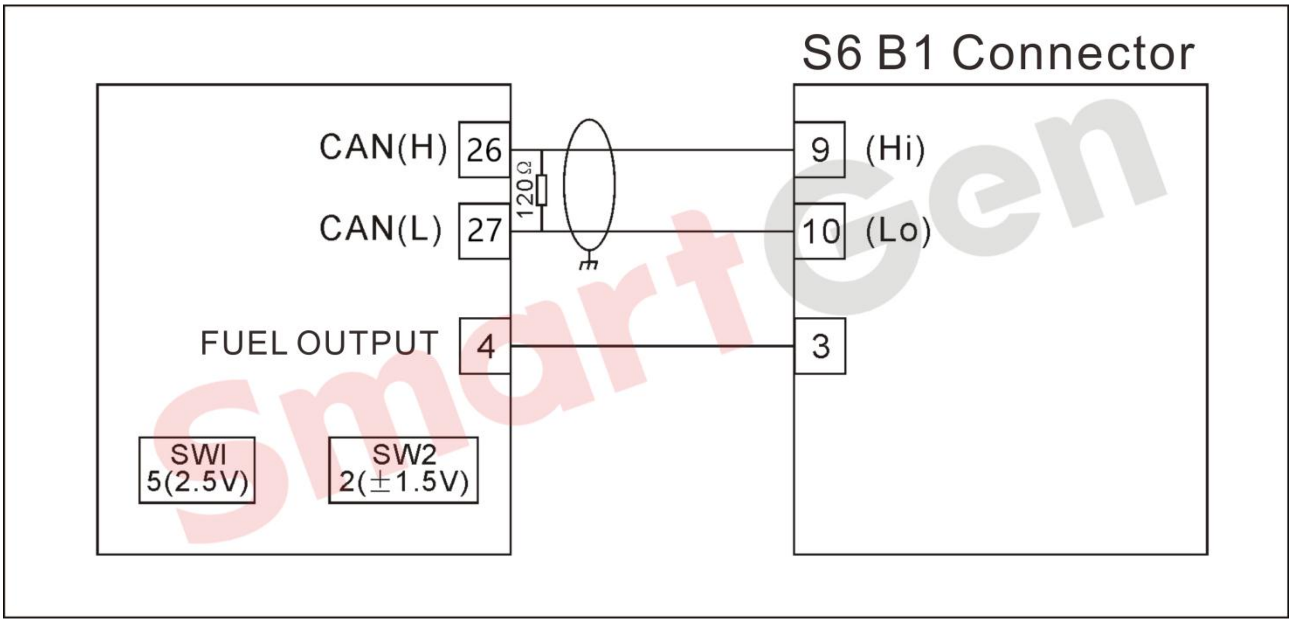


Fig. 193 SCANIA S6 Engine

4.4.2.18 TOHO

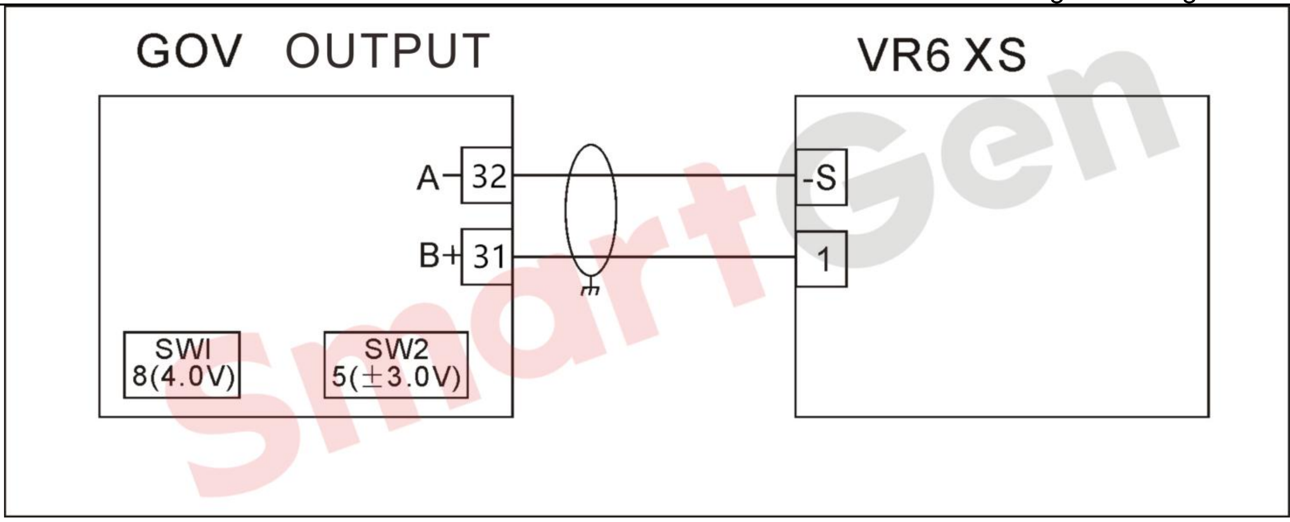


Fig. 194 TOHOXS*

4.4.2.19 WOODWARD

4.4.2.19.1 721 Digital GOV

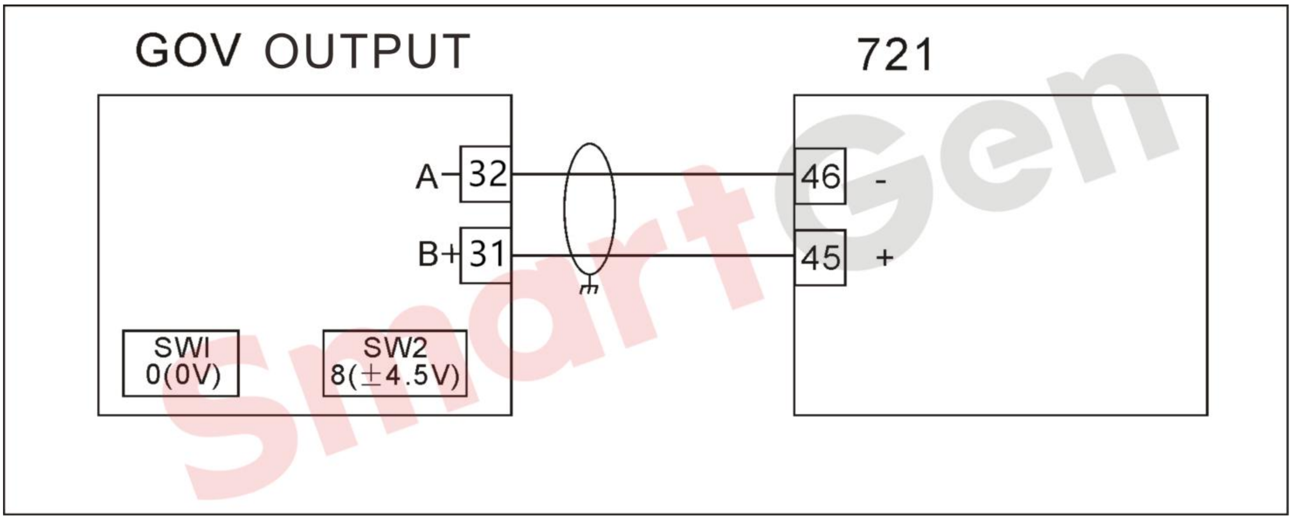


Fig. 195 WOODWARD 721 Digital GOV

4.4.2.19.2 2301A GOV

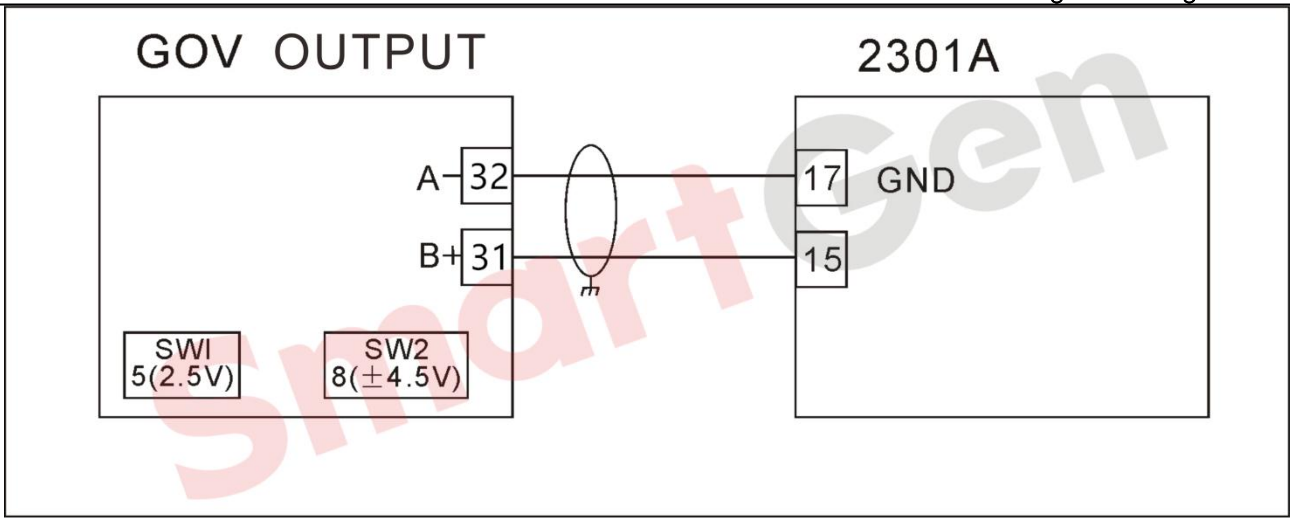


Fig. 196 WOODWARD 2301A Digital GOV

4.4.2.19.3 2301A Load Sharing

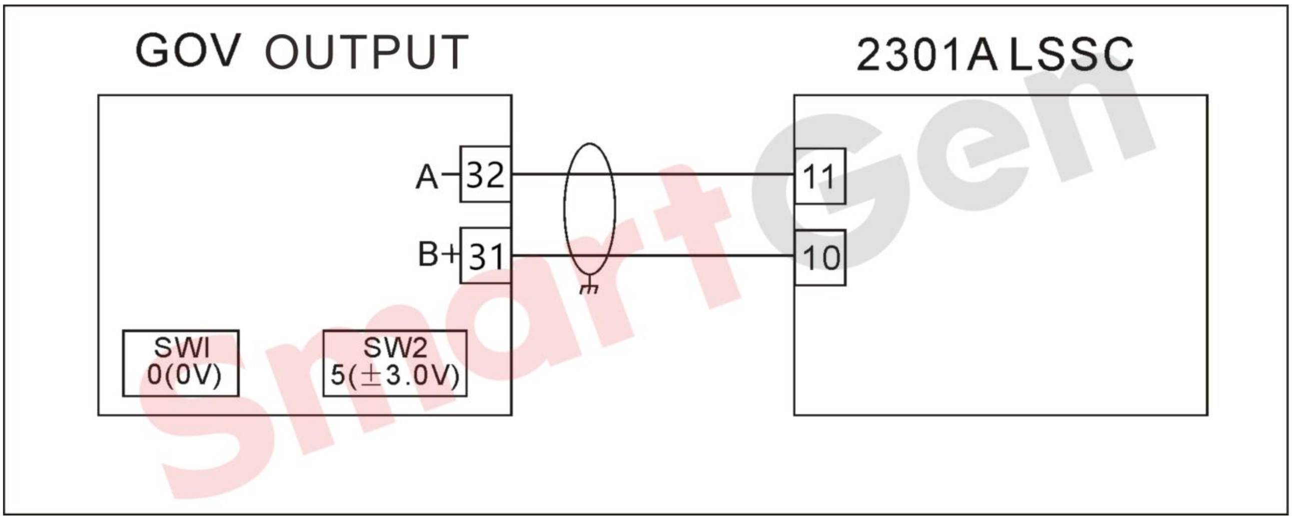


Fig. 197 WOODWARD 2301A Load Sharing

4.4.2.19.4 DPG

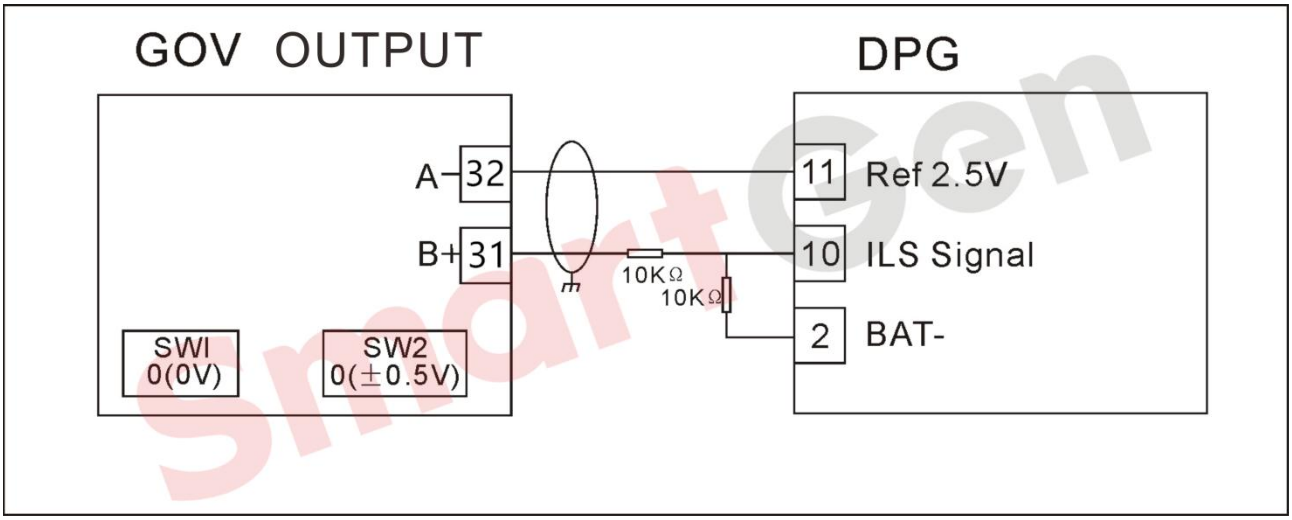


Fig. 198 WOODWARD DPG

4.4.2.19.5 EPG(ELECTRICALLYPOWEREDGOVERNORS)*

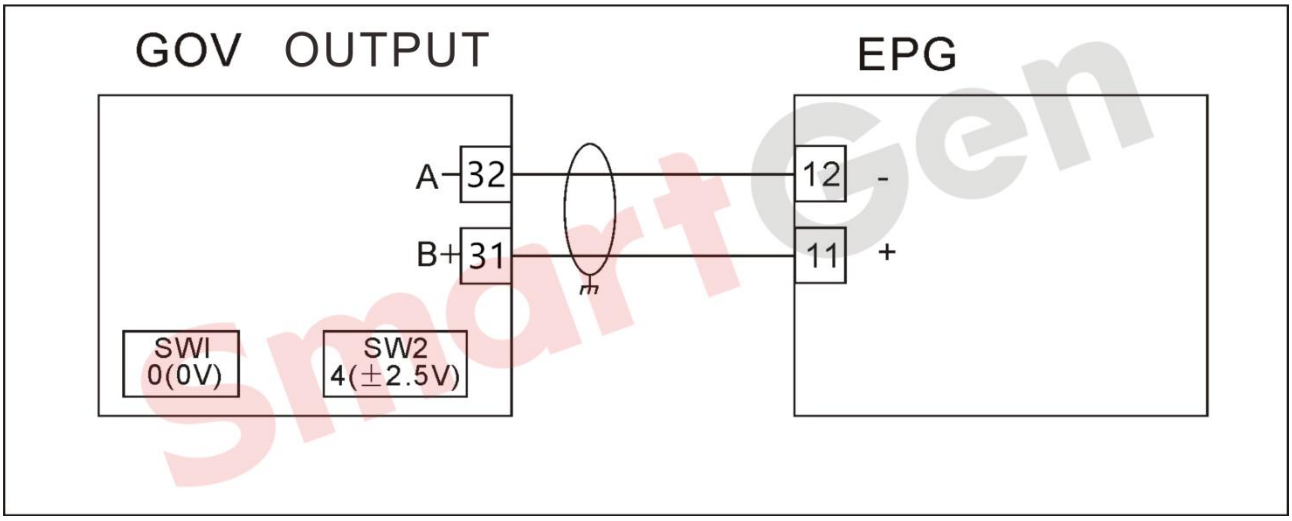


Fig. 199 WOODWARD EPG

4.4.2.19.6 PROACTI/II

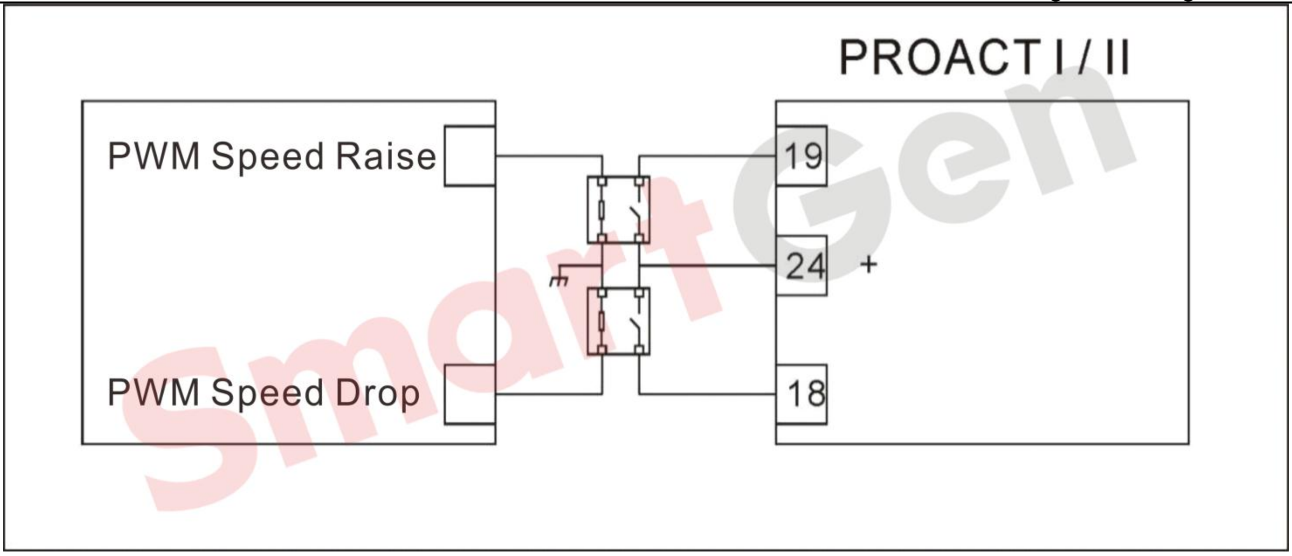


Fig. 200 WOODWARD PROACTI/II

4.4.3 AVR Wiring

4.4.3.1 STAMFORD

SX421/SX440*/SX465-2/AS440/MX321/MX325/MX327/MX341

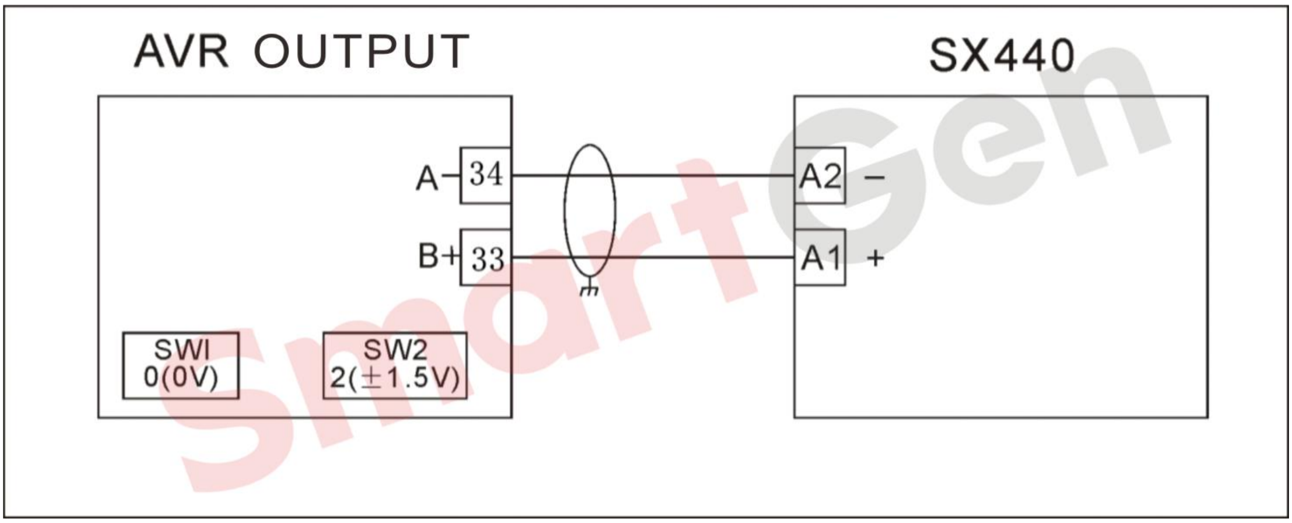


Fig. 201 STAMFORD SX440

4.4.3.2 MARATHON

4.4.3.2.1 DVR2000/DVR2000C

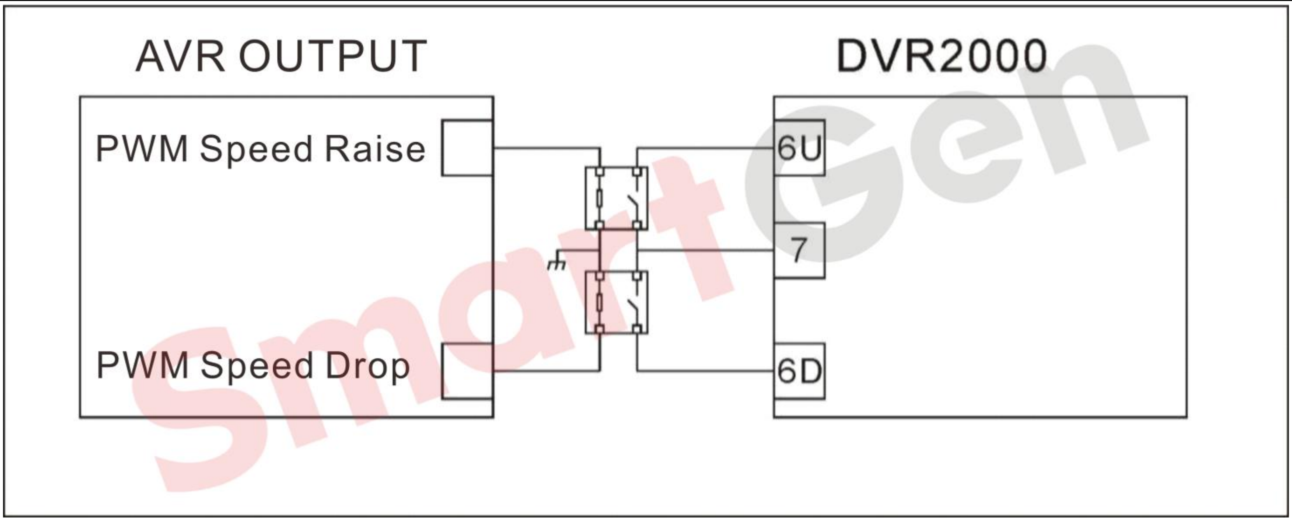


Fig. 202MARATHON DVR2000

4.4.3.2.2 DVR2000E

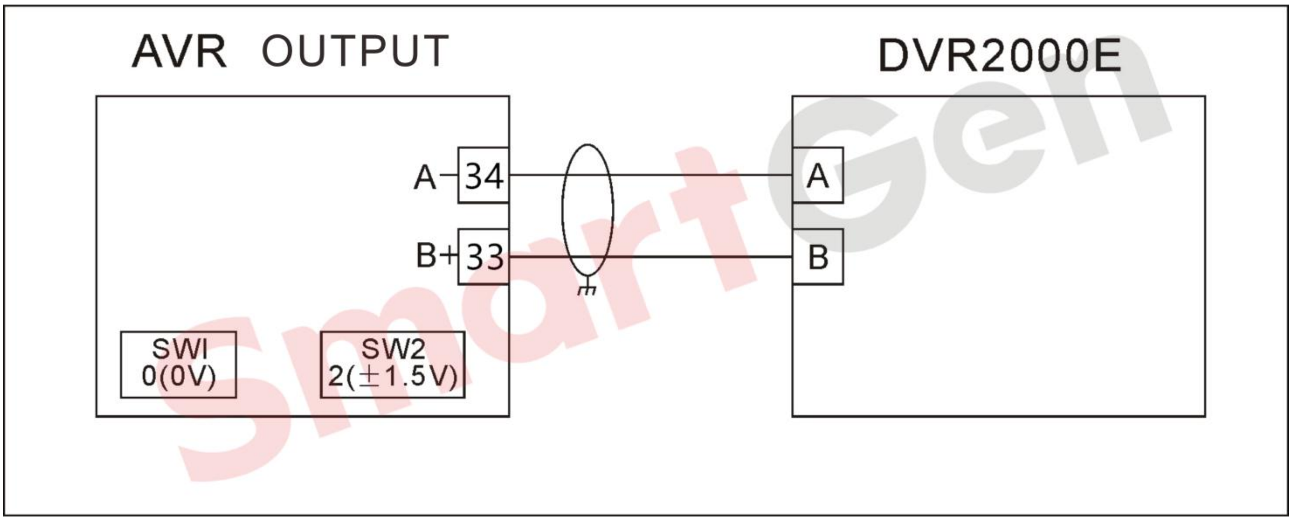


Fig. 203 MARATHON DVR2000E

4.4.3.2.3 PM100*/PM200*

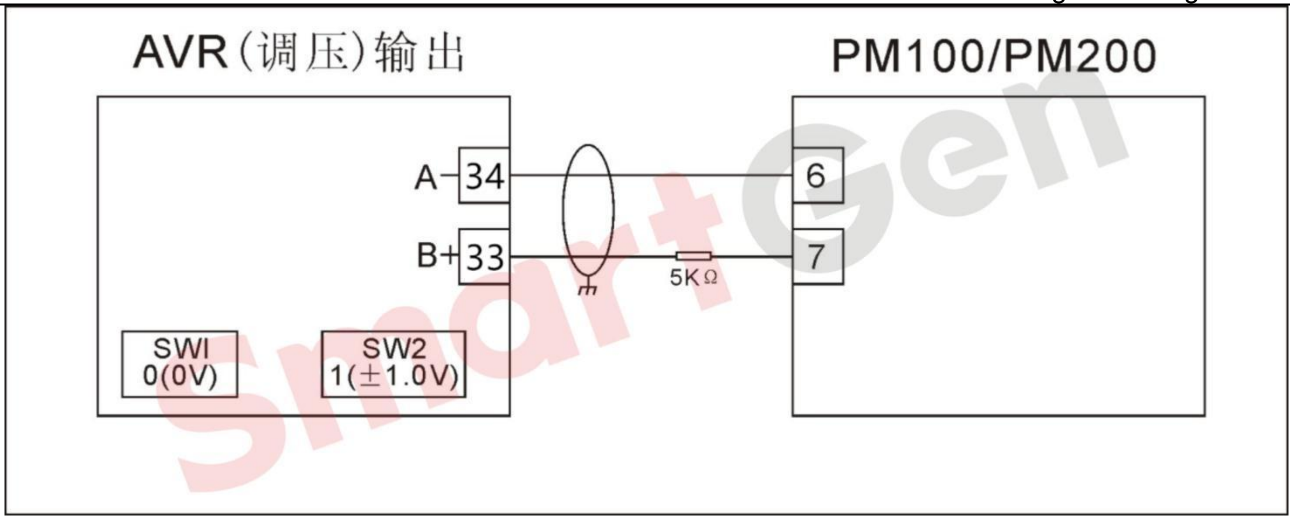


Fig. 204 MARATHON PM100*/PM200*

4.4.3.3 LEROYSOMER

4.4.3.3.1 R230/R438*/R448/R449

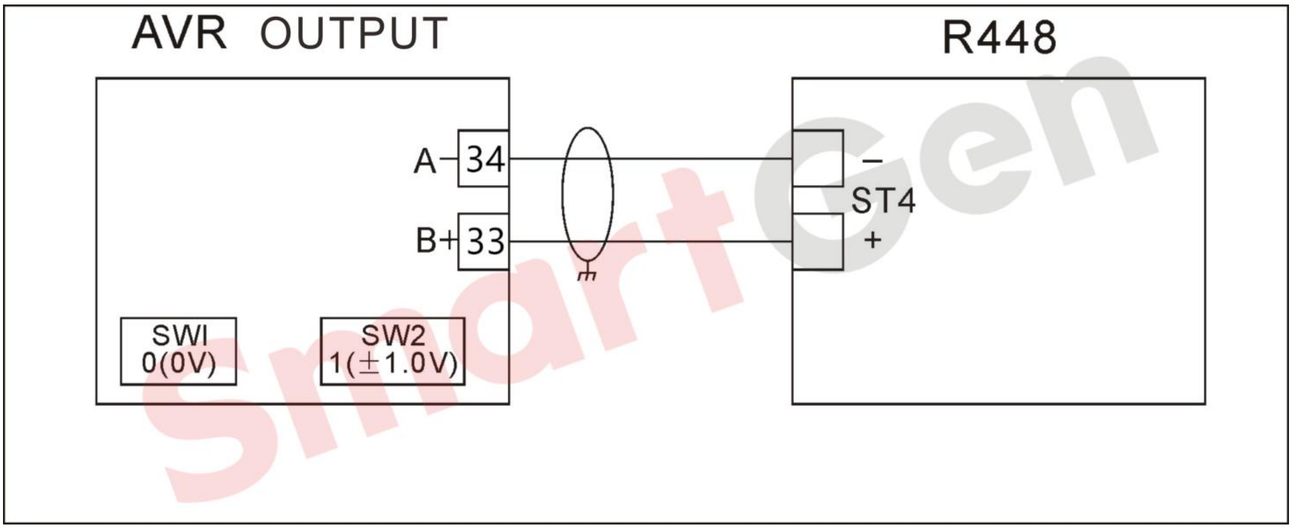


Fig. 205 LEROYSOMER R448

4.4.3.3.2 R6103F

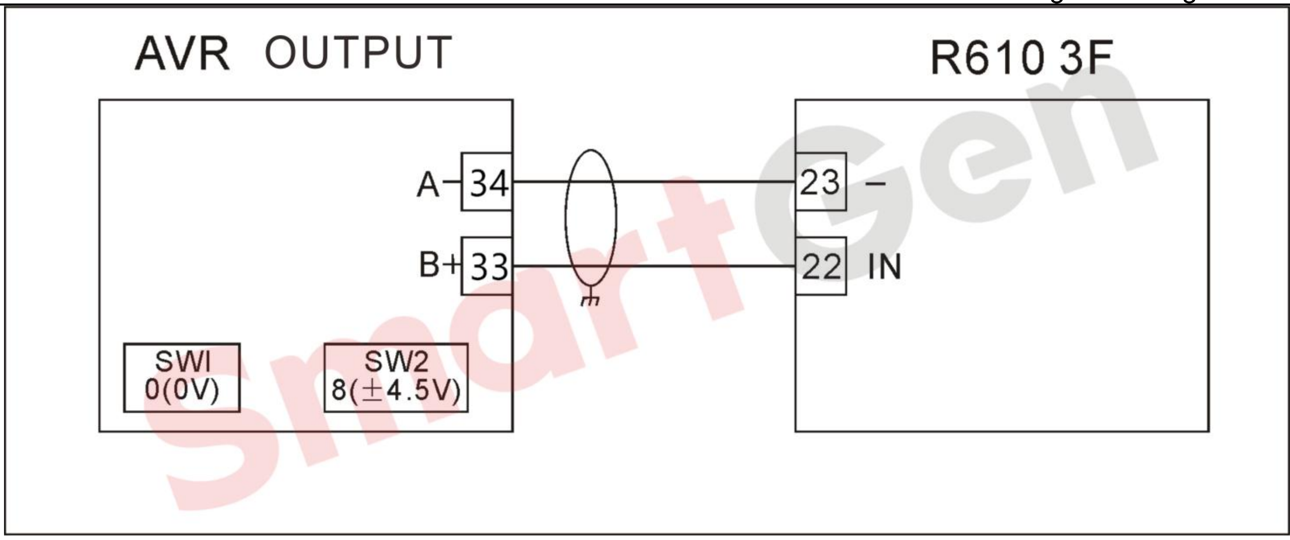


Fig. 206 LEROYSOMER R6103F

4.4.3.4 ENGGA WT-2/WT-3

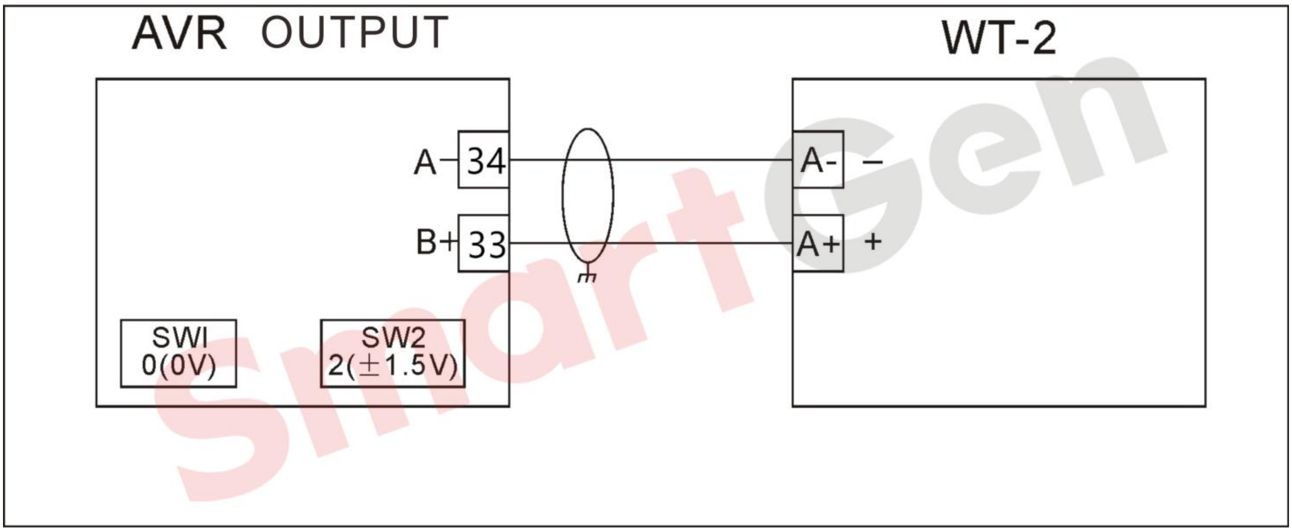


Fig. 207 ENGGA WT2，WT3

4.4.3.5 MECCALTE

4.4.3.5.1 DSR

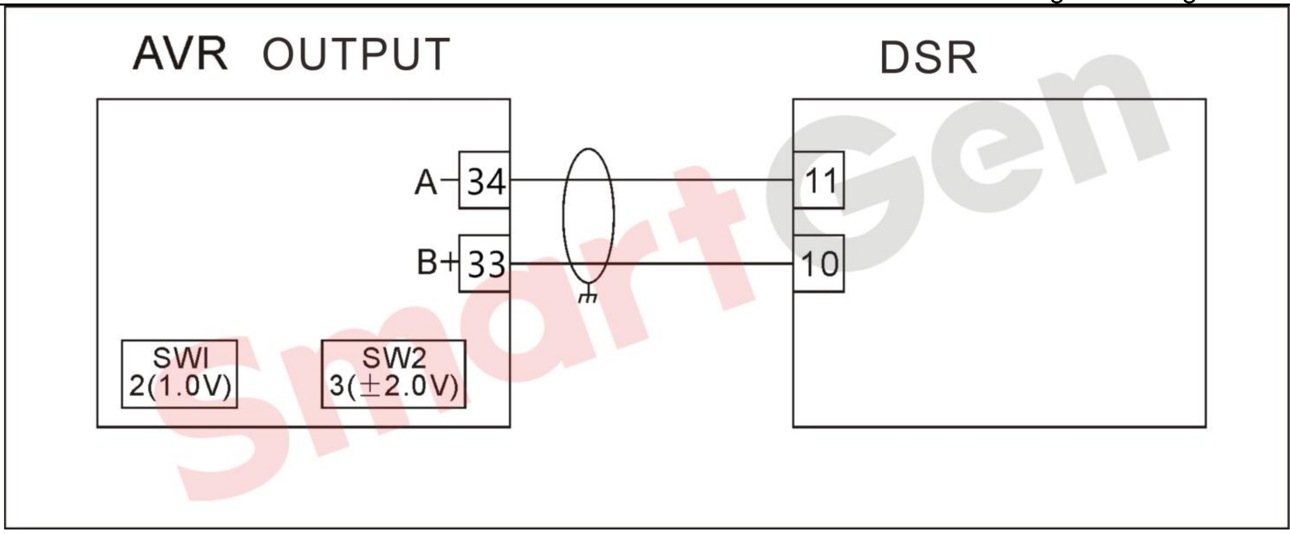


Fig. 208 MECCALTE DSR

4.4.3.5.2 S.R.7*

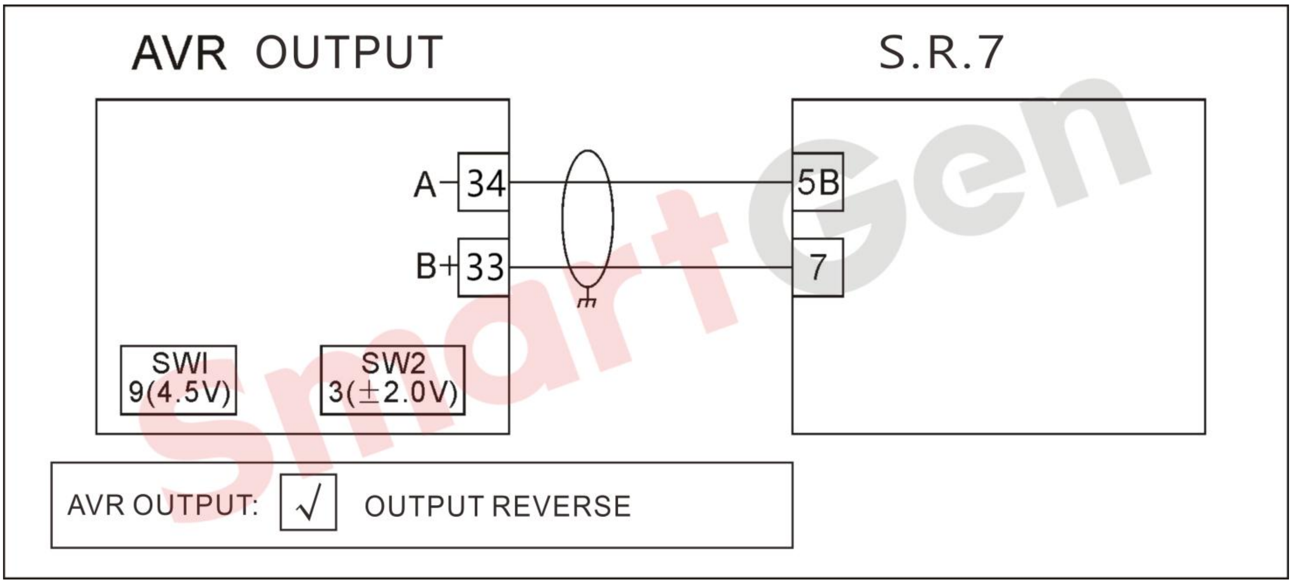


Fig. 209 MECCALTE S.R.7*

4.4.3.5.3 U.V.R.*

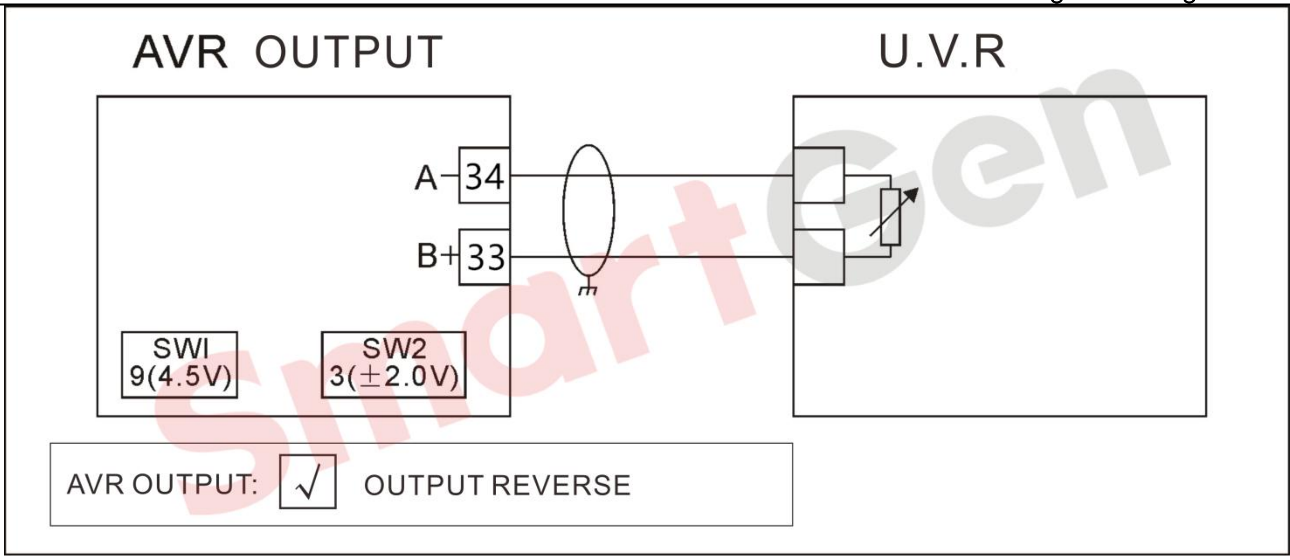


Fig. 210 MECCALTE U.V.R*

4.4.3.5.4 DER1

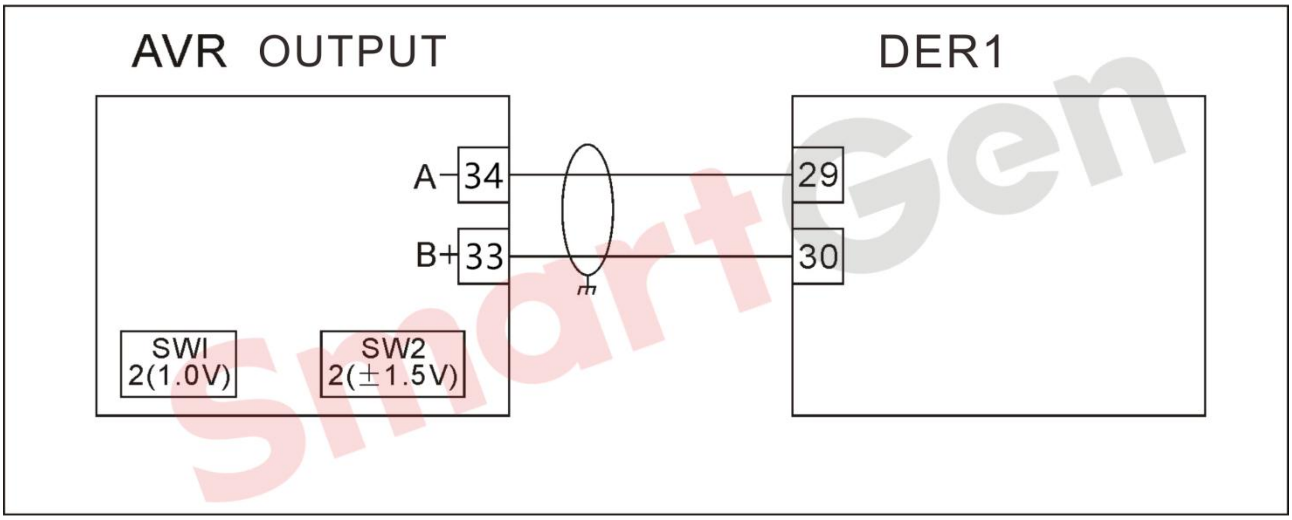


Fig. 211 MECCALTE DER1

4.4.3.6 MARELLIMOTOR

4.4.3.6.1 M16FA655A*

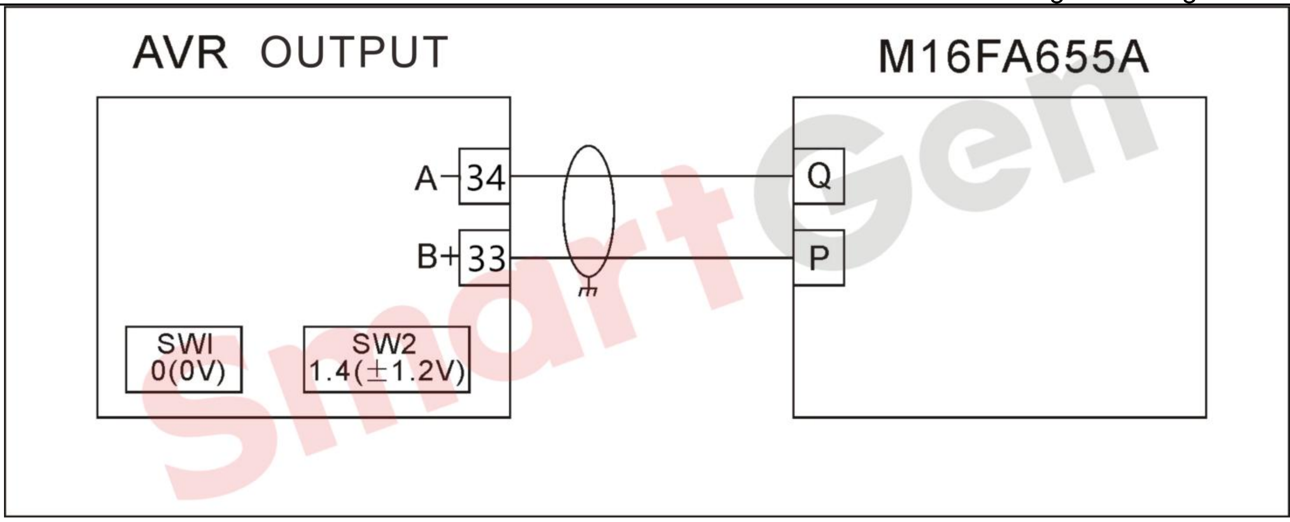


Fig. 212 MARELLIMOTOR(M16FA655A*)

4.4.3.6.2 M40FA610A

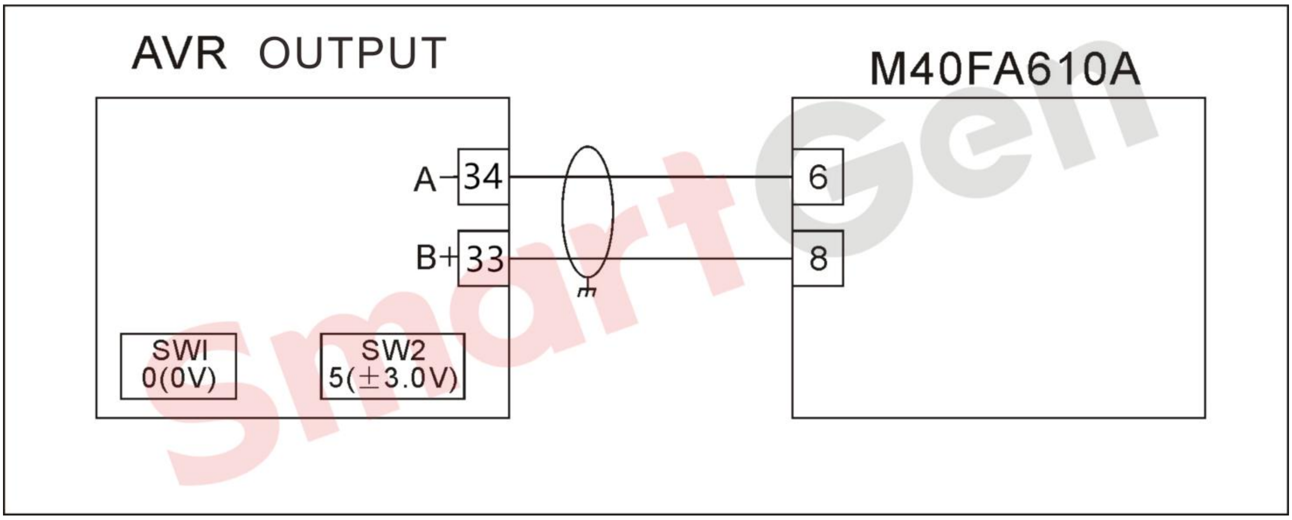


Fig. 213 MARELLIMOTOR(M40FA610A)

4.4.3.6.3 M40FA640A*

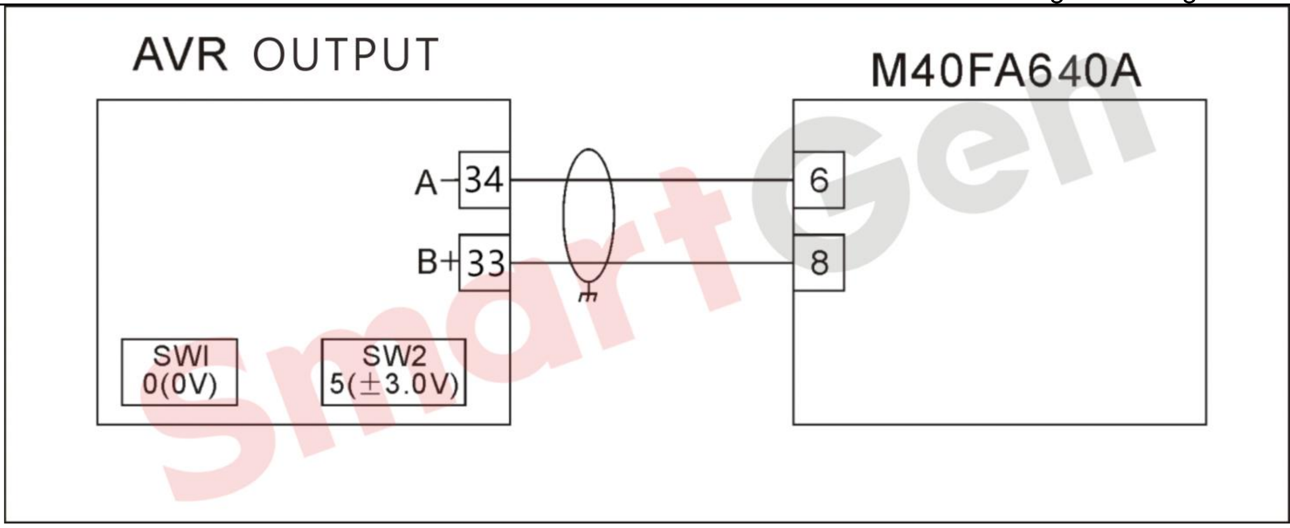


Fig. 214 MARELLIMOTOR(M40FA640A)

4.4.3.7 BASLER

4.4.3.7.1 AVC63-12

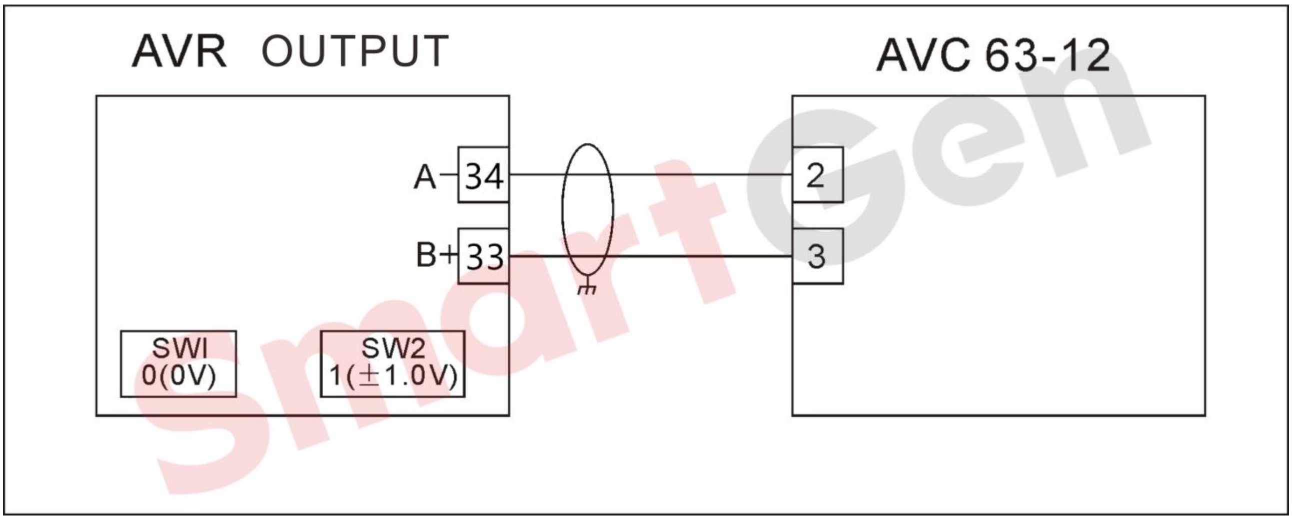


Fig. 215 BASLER(AVC63-12)

4.4.3.7.2 DECS15/DECS100

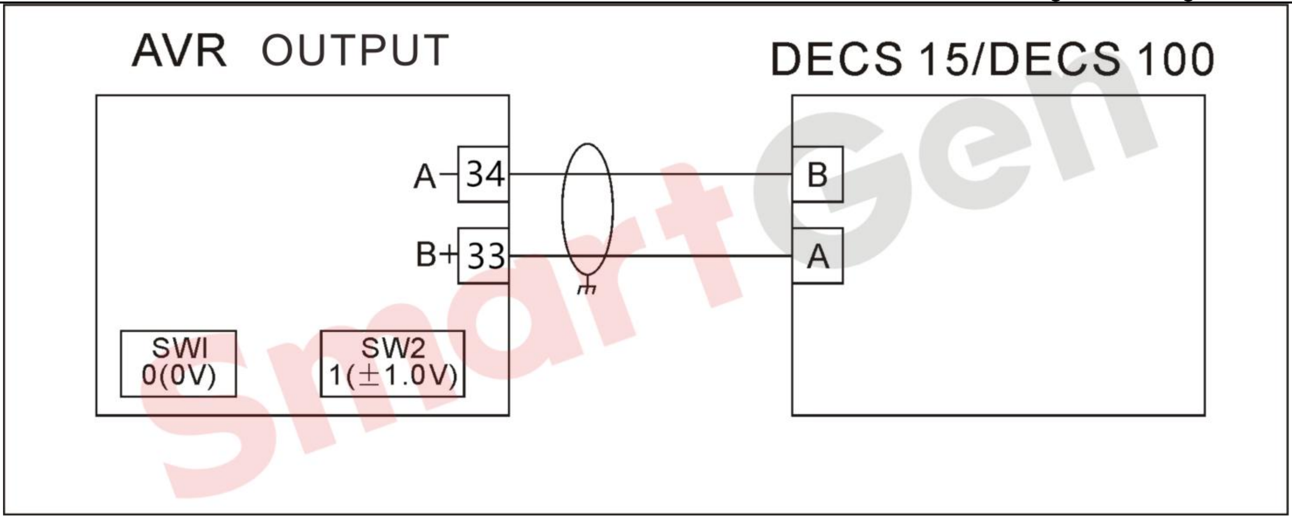


Fig. 216 BASLER(DECS15/DECS100)

4.4.3.7.3 DECS200

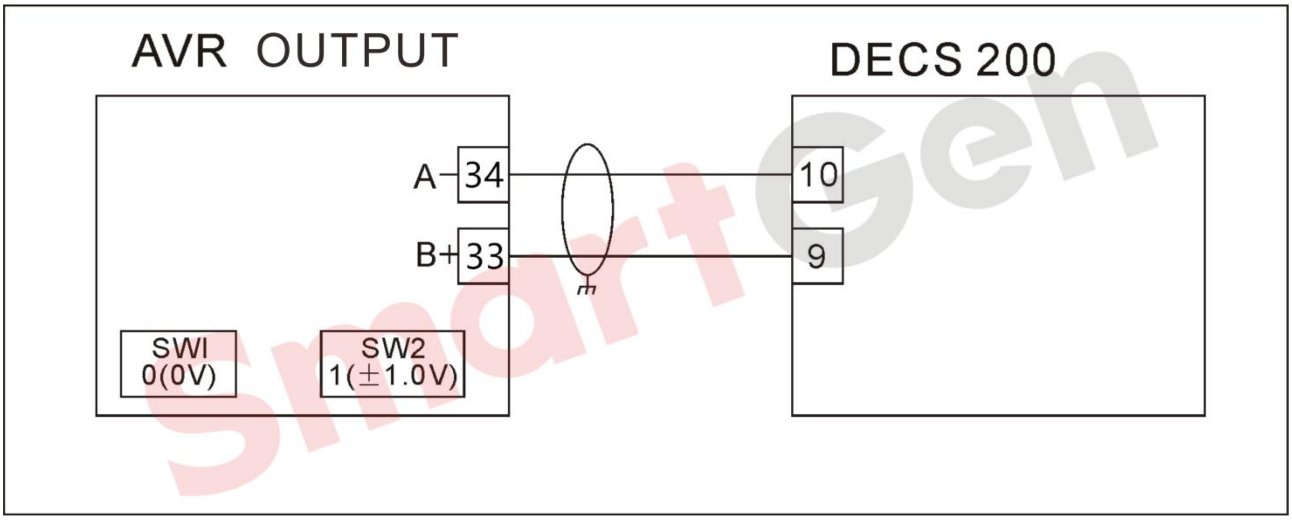


Fig. 217 BASLER(DECS200)

4.4.3.7.4 SSR

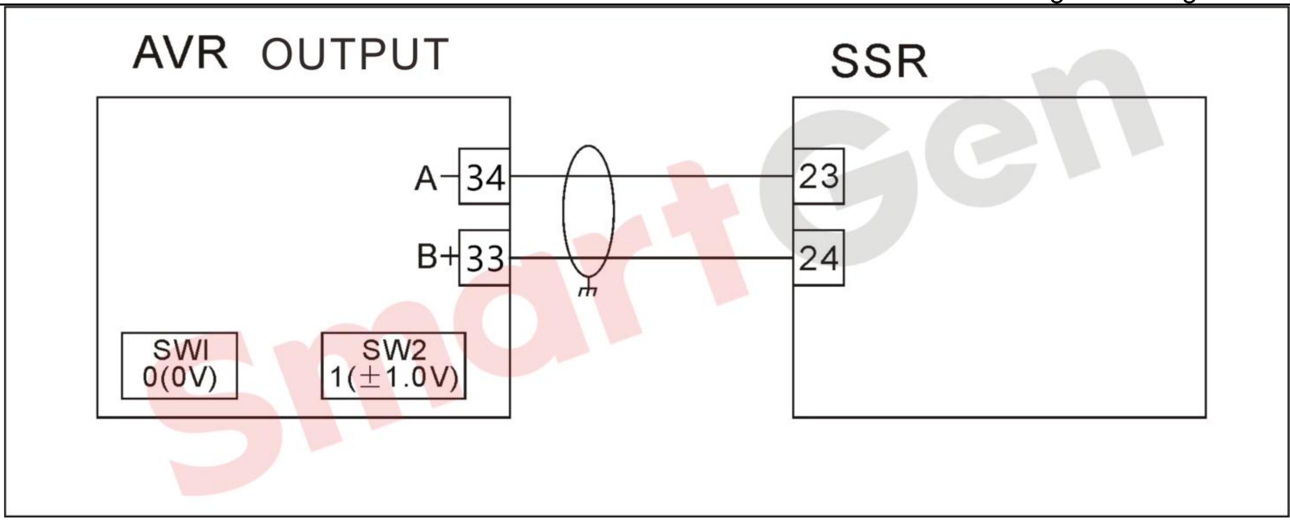


Fig. 218 BASLER(SSR)

4.4.3.8 CATERPILLAR

4.4.3.8.1 CDVR

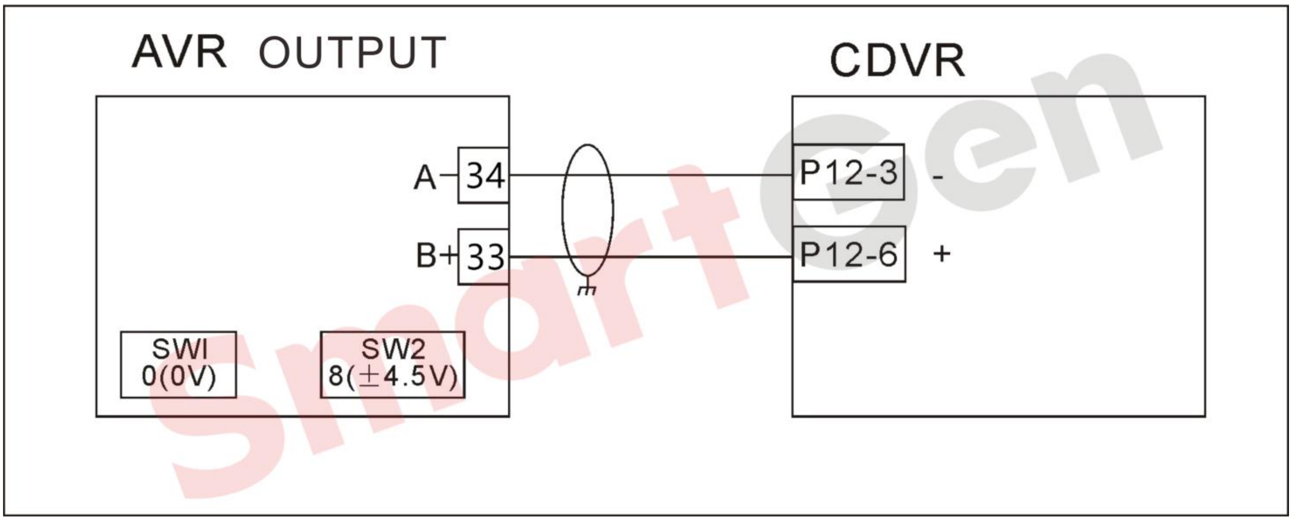


Fig. 219 CATERPILLAR CDVR

4.4.3.8.2 VR3

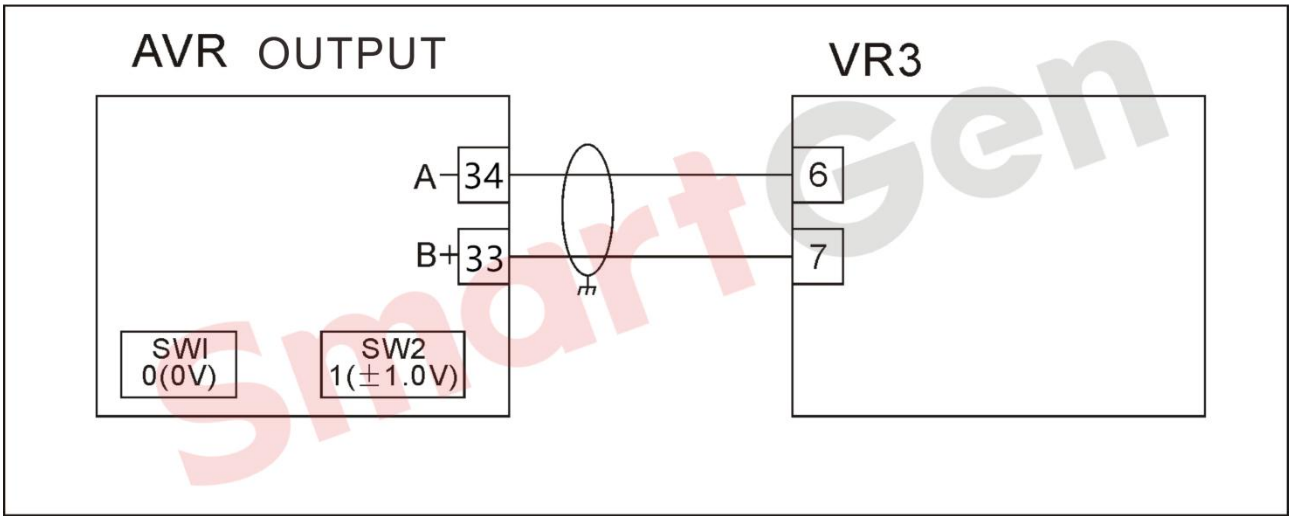


Fig. 220 CATERPILLAR VR3

4.4.3.8.3 VR6

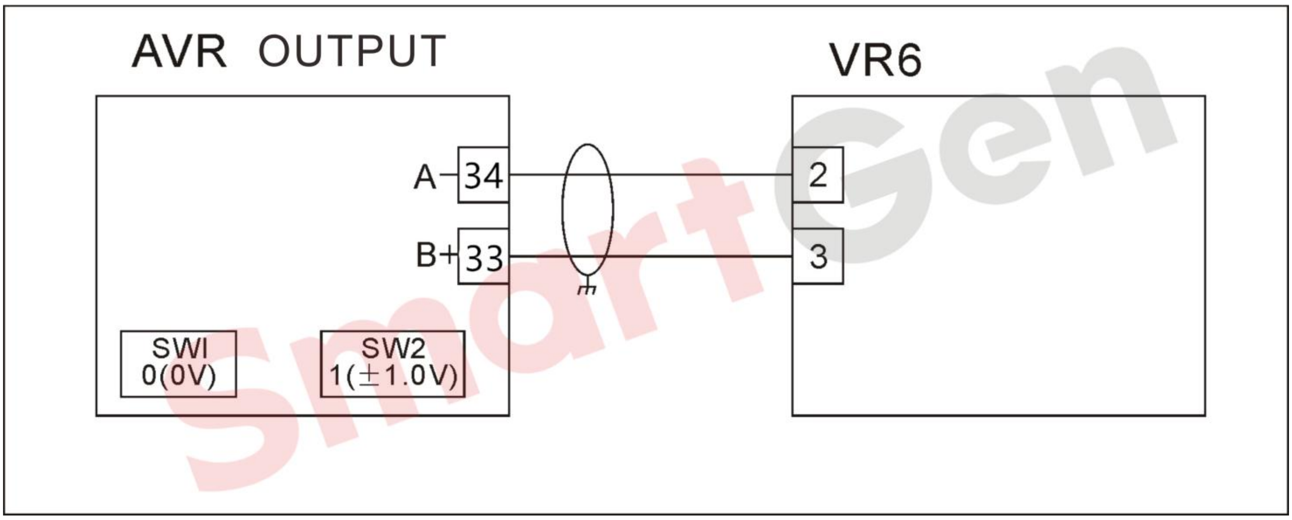


Fig. 221 CATERPILLAR VR6

4.4.3.8.4 COSIMAT(COSIMATN)

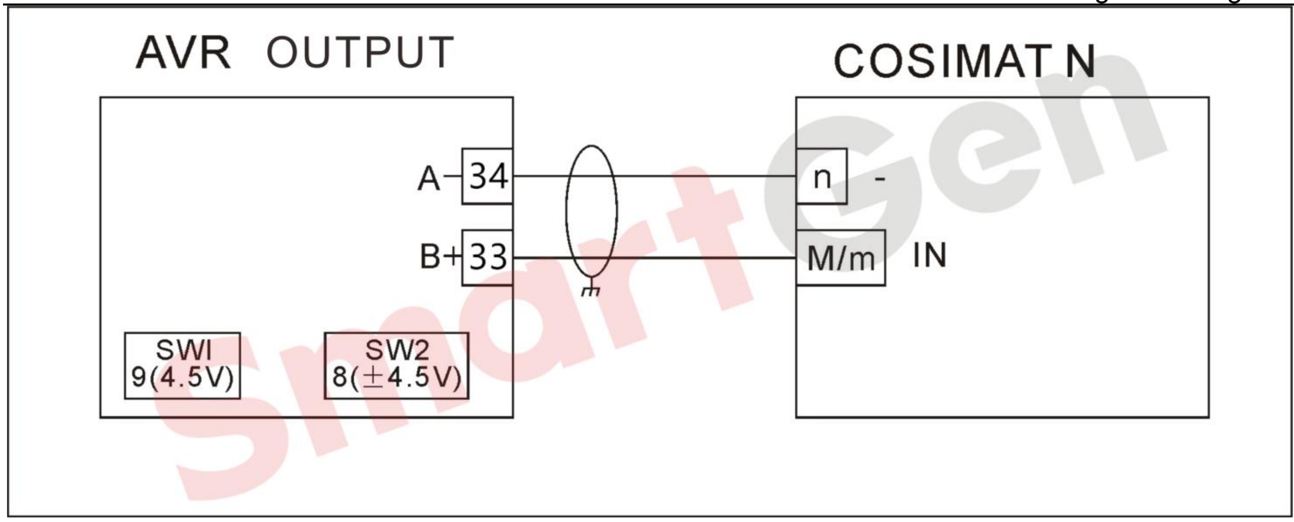


Fig. 222 COSIMAT(COSIMATN)

4.4.3.8.5 GRAMEYER(GRT7-TH*)

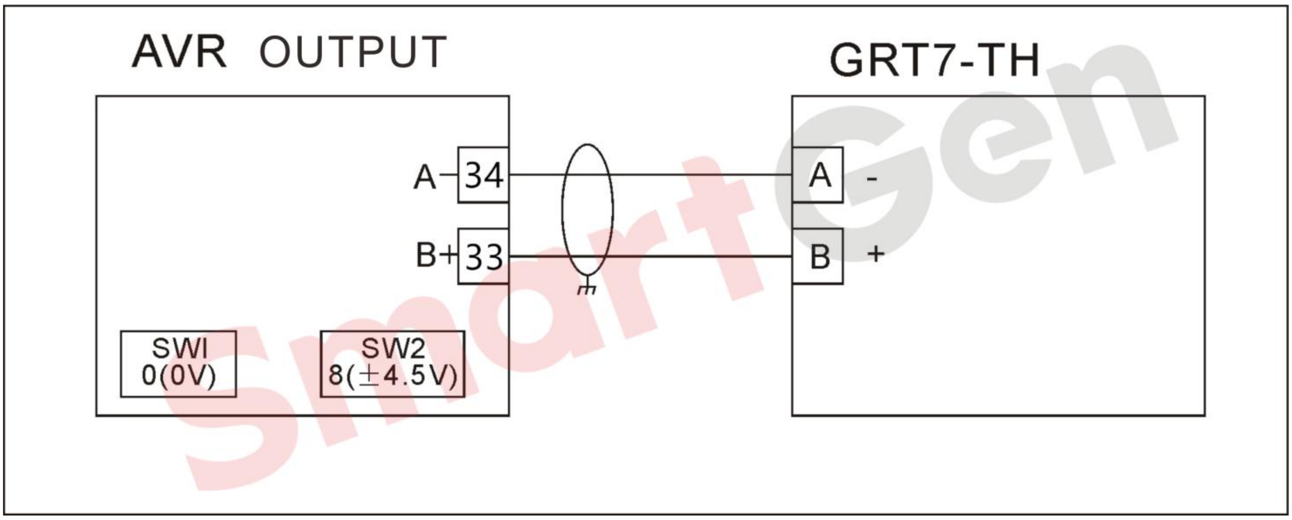


Fig. 223 GRAMEYER(GRT7-TH*)

4.4.3.9 KATO(K65-12B/K125-10B)

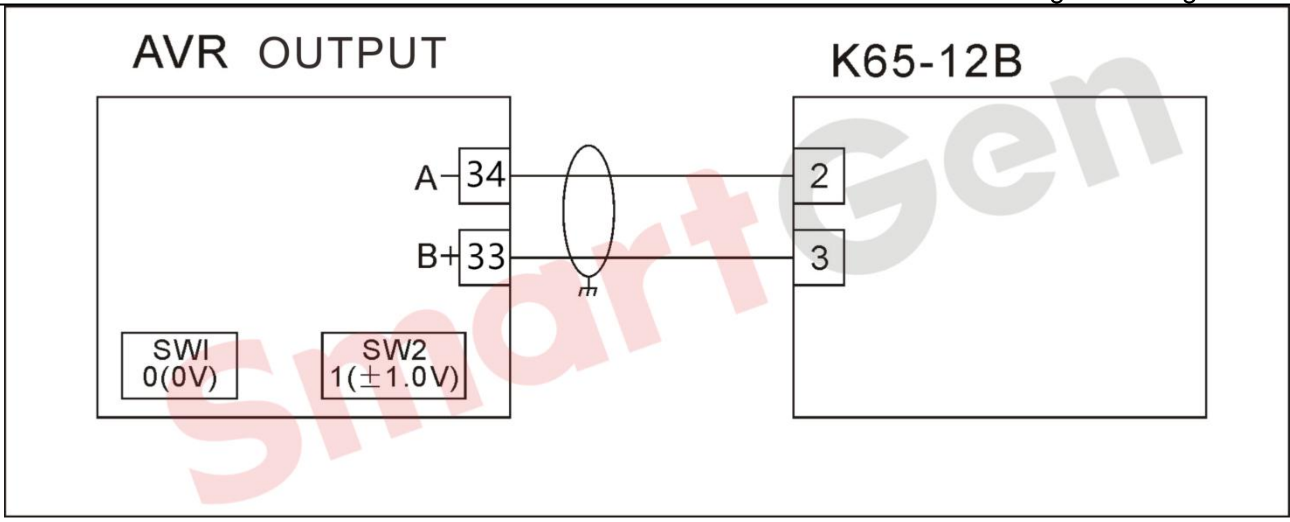


Fig. 224 KATO(K65-12B)

4.5 Parameter Setting of EFI Unit

4.5.1 CUMMINS ISB/ISBE(CUMMINS)

Table 34 Connector B

Terminals of controller	Connector B	Remark
Fuel relay output	39	
Starting relay output	-	Connected with starter coil directly;
Auxiliary output port 1	Expansion 30A relay; providing battery voltage for terminal 01, 07, 12, 13.	ECU power Set output 1 as "ECU power"

Table 35 9-Pin Connector

Terminals of controller	9 pins connector	Remark
CAN GND	SAEJ1939 shield	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	SAEJ1939 signal	Impedance 120Ω connecting line is recommended.
CAN(L)	SAEJ1939 return	Impedance 120Ω connecting line is recommended.

Engine type: Cummins ISB.

4.5.2 CUMMINS QSM11(CUMMINS)

It is suitable for CM570 engine control module. Engine type is QSM11 G1, QSM11 G2.

Table 36 C1 Connector

Terminals of controller	C1 Connector	Remark
Fuel relay output	5&8	External expansion relay; on fuel output, make port 5 and port 8 of C1 connector be connected;
Starting relay output	-	Connected to starter coil directly;

Table 37 3-Pin Data Link Connector

Terminals of controller	3 pins data link connector	Remark
CANGND	C	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	A	Impedance 120Ω connecting line is

Terminals of controller	3 pins data link connector	Remark
		recommended.
CAN(L)	B	Impedance 120Ω connecting line is recommended.

Engine type: Cummins ISB.

4.5.3 CUMMINS QSL9(CUMMINS)

Suitable for CM850 engine control module.

Table 38 50-Pin Connector

Terminals of controller	50 pins connector	Remark
Fuel relay output	39	
Starting relay output	-	Connected to starter coil directly;

Table 39 9-Pin Connector

Terminals of controller	9 pins connector	Remark
CAN GND	SAE J1939 shield-E	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	SAE J1939 signal-C	Impedance 120Ω connecting line is recommended.
CAN(L)	SAE J1939 return-D	Impedance 120Ω connecting line is recommended.

Engine type: Cummins-CM850.

4.5.4 CUMMINS QSX15-CM570(CUMMINS)

It is suitable for CM570 engine control module. Engine type is QSX15 etc.

Table 40 50-Pin Connector

Terminals of controller	50 pins connector	Remark
Fuel relay output	38	Injection switch;
Starting relay output	-	Connected to starter coil directly;

Table 41 9-Pin Connector

Terminals of controller	9 pins connector	Remark
CANGND	SAE J1939 shield-E	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	SAE J1939 signal-C	Impedance 120Ω connecting line is

		recommended.
CAN(L)	SAE J1939 return-D	Impedance 120Ω connecting line is recommended.

Engine type: Cummins QSX15-CM570.

4.5.5 CUMMINSGCS-MODBUS(CUMMINS)

It is suitable for GCS engine control module. Use RS485-MODBUS to read information of engine. Engine types are QSX15, QST30, QSK23/45/60/78 and so on.

Table 42 D-SUB Connector 06

Terminals of controller	D-SUB Connector 06	Remark
Fuel relay output	5&8	Outside expansion relay; on fuel output, make port 05 and 08 of connector 06 be connected.
Starting relay output	-	Connected to starter coil directly;
RS485GND	20	CAN communication shielding line (Connected with ECU terminal only);
RS485+	21	Impedance 120Ω connecting line is recommended.
RS485-	18	Impedance 120Ω connecting line is recommended.

Engine type: Cummins QSK-MODBUS, Cummins QST-MODBUS, Cummins QSX-MODBUS.

4.5.6 CUMMINS QSM11(XiM11(CUMMINS)

Table 43 Engine OEM Connector

Terminals of controller	OEM connector of engine	Remark
Fuel relay output	38	
Starting relay output	-	Connected with starter coil directly;
CANGND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	46	Impedance 120Ω connecting line is recommended.
CAN(L)	37	Impedance 120Ω connecting line is recommended.

Engine type: Common J1939.

4.5.7 CUMMINSQSZ13(Dongfeng CUMMINS)

Table 44 Engine OEM Connector

Terminals of controller	OEM connector of engine	Remark
Fuel relay output	45	
Starting relay output	-	Connected to starter coil directly;
Programmable output 1	16&41	Set as idling speed control; (N/C) output; by expansion relay, make 16&41 close as the controller is running.
Programmable output 12	19&41	Set as pulse speed raising control; (N/O) output; by expansion relay, make 19&41 for 0.1s as the controller is entering warming-up time.
CAN GND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	1	Impedance 120Ω connecting line is recommended.
CAN(L)	21	Impedance 120Ω connecting line is recommended.

Engine type: Common J1939.

4.5.8 DETROIT DIESEL DDEC III/IV(DETROIT)

Table 45 Engine CAN Port

Terminals of controller	CAN port of engine	Remark
Fuel relay output	Expansion 30A relay, proving battery voltage for ECU;	
Starting relay output	-	Connected to starter coil directly;
CAN GND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	CAN(H)	Impedance 120Ω connecting line is recommended.
CAN(L)	CAN(L)	Impedance 120Ω connecting line is recommended.

Engine type: Common J1939.

4.5.9 DEUTZ EMR2(DEUTZ)

Table 46 F Connector

Terminals of controller	F connector	Remark
Fuel relay output	Expansion 30A relay, proving	

	battery voltage for 14; Fuse is 16A.	
Starting relay output	-	Connected to starter coil directly;
-	1	Connected to battery negative;
CANGND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	12	Impedance 120Ω connecting line is recommended.
CAN(L)	13	Impedance 120Ω connecting line is recommended.

Engine type: Volvo EDC4.

4.5.10 JOHN DEERE

Table 47 21-Pin Connector

Terminals of controller	21 pins connector	Remark
Fuel relay output	G，J	
Starting relay output	D	
CANGND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	V	Impedance 120Ω connecting line is recommended.
CAN(L)	U	Impedance 120Ω connecting line is recommended.

Engine type: John Deere.

4.5.11 MTUADEC (SMART MODULE)

Suitable for MTU engines with ADEC (ECU8) and SMART module.

Table 48 ADEC

Terminals of controller	ADEC (X1 port)	Remark
Fuel relay output	X110	X1 9 shall connect battery negative.
Starting relay output	X134	X1 33 shall connect battery negative.

Table 49 SMART

Terminals of controller	SMART (X4 port)	Remark
CAN GND	X43	CAN communication shielding line (Connected with ECU terminal only);

CAN(H)	X41	Impedance 120Ω connecting line is recommended.
CAN(L)	X42	Impedance 120Ω connecting line is recommended.

Engine type:MTU-ADEC

4.5.12 MTUADEC (SAM MODULE)

It is suitable for MTU engine with ADEC (ECU7) and SAM module.

Table 50 ADEC

Terminals of controller	ADEC (X1 port)	Remark
Fuel relay output	X143	X1 28 shall connect negative of battery.
Starting relay output	X137	X1 22 shall connect negative of battery.

Table 51 SAM

Terminals of controller	SAM (X23 port)	Remark
CANGND	X233	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	X232	Impedance 120Ω connecting line is recommended.
CAN(L)	X231	Impedance 120Ω connecting line is recommended.

Engine type: Common J1939.

4.5.13 PERKINS

It is suitable for ADEM3/ADEM4 engine control module. Engine type is 2306, 2506, 1106, and 2806.

Table 52 Connector

Terminals of controller	Connector	Remark
Fuel relay output	1, 10, 15, 33, 34	
Starting relay output	-	Connected to starter coil directly;
CAN GND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	31	Impedance 120Ω connecting line is recommended.
CAN(L)	32	Impedance 120Ω connecting line is recommended.

Engine type: Perkins.

4.5.14 SCANIA

It is suitable for S6 engine control module. Engine type is DC9, DC12, and DC16.

Table 53 B1 Connector

Terminals of controller	B1 Connector	Remark
Fuel relay output	3	
Starting relay output	-	Connected to starter coil directly;
CANGND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	9	Impedance 120Ω connecting line is recommended.
CAN(L)	10	Impedance 120Ω connecting line is recommended.

Engine type: Scania

4.5.15 VOLVO EDC3(VOLVO)

Suitable engine control mode is TAD1240, TAD1241, and TAD1242.

Table 54 "Stand Alone" Connector

Terminals of controller	Standalone Connector	Remark
Fuel relay output	H	
Starting relay output	E	
Programmable output 1	P	ECU power; Set output 1 as "ECU power";

Table 55 "Data Bus" Connector

Terminals of controller	Databus Connector	Remark
CANGND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	1	Impedance 120Ω connecting line is recommended.
CAN(L)	2	Impedance 120Ω connecting line is recommended.

Engine type: Volvo.

NOTE: When this engine type is selected, preheating time should be set to at least 3 seconds.

4.5.16 VOLVO EDC4

Suitable engine types are TD520, TAD520 (optional), TD720, TAD720 (optional), TAD721, TAD722, and TAD732.

Table 56 VOLVOEDC4

Terminals of controller	Connector	Remark
Fuel relay output	Expansion 30A relay, providing battery voltage for terminal 14. Fuse is 16A.	
Starting relay output	-	Connected to starter coil directly;
	1	Connected to negative of battery;
CANGND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	12	Impedance 120Ω connecting line is recommended.
CAN(L)	13	Impedance 120Ω connecting line is recommended.

Engine type: Volvo EDC4.

4.5.17 VOLVO EMS2

Volvo Engine types are TAD734, TAD940, TAD941, TAD1640, TAD1641, and TAD1642.

Table 57 Engine CAN Port

Terminals of controller	Engine's CAN port	Remark
Programmable output 1	6	ECU stop; Set output 1 "ECU stop";
Programmable output 2	5	ECU power; Set output 2 "ECU power";
	3	Power negative
	4	Power Positive
CANGND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	1(Hi)	Impedance 120Ω connecting line is recommended.
CAN(L)	2(Lo)	Impedance 120Ω connecting line is recommended.

Engine type: Volvo-EMS2.

NOTE: When this engine type is selected, preheating time should be set to at least 3 seconds.

4.5.18 YUCHAI

It is suitable for Yuchai BOSCH common rail electronic-controlled engine.

Table 58 Engine 42-Pin Port

Terminals of controller	Engine 42 pins port	Remark
Fuel relay output	1.40	Connected to engine ignition lock;
Starting relay output	-	Connected to starter coil directly;
CANGND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	1.35	Impedance 120Ω connecting line is recommended.
CAN(L)	1.34	Impedance 120Ω connecting line is recommended.

Table 59 Engine 2-Pin

Battery	Engine 2 pins	Remark
Battery negative	1	Wire diameter $2.5mm^2$
Battery positive	2	Wire diameter $2.5mm^2$

Engine type: BOSCH

4.5.19 WEICHAI

It is suitable for Weichai BOSCH common rail electronic-controlled engine.

Table 60 Engine Port

Terminals of controller	Engine port	Remark
Fuel relay output	1.40	Connected to engine ignition lock;
Starting relay output	1.61	
CANGND	-	CAN communication shielding line (Connected with ECU terminal only);
CAN(H)	1.35	Impedance 120Ω connecting line is recommended.
CAN(L)	1.34	Impedance 120Ω connecting line is recommended.

Engine type: Weichai.

If there is any question of connection between controller and ECU communication, please feel free to contact SmartGen's service

5 Summary

Smartgen products involved in this article include:

——HGM9510, HGM9510N Genset Parallel Controller.

——HGM9520 Genset and Mains Parallel Controller.

——HGM9530N Genset Parallel Redundant Controller.

——HGM9560 Unit Bus and Mains Parallel Controller.

——HGM9580 Unit Bus and Unit Bus Parallel Controller.

——HGM6110N Genset Controller.

——BAC06A, BAC2410, BAC2420 Battery chargers.

——HVD100, and HVD300 Voltage Detection Multi-Function Protection Device (Provides Remote Start Signal).

——DIN16A Digital Input Module (When there are many external digital signals, the communication is extended through the ECU J1939 interface).

——DOUT16 Digital Output Module (When multiple digital outputs are required, communication is extended through the ECU J1939 interface).

——HEP300 Electronic Potentiometer (In electronic speed regulation, voltage regulation and parallel system, it is necessary to convert digital signal or analog voltage signal into voltage, current, PWM signal and other functions).

——CMM366A-4G, CMM366B-4G, CAMM366CAN-4G, CMM366A-ET, CMM366A-WIFI Cloud Monitoring Module (Units need cloud service).

Visit SmartGen official website http://www.smartgen.com.cn/ And http://www.smartgen.cn/ for detailed product information

In addition, more product application solutions and application cases can be obtained through the official website.