Application note

Generator protection REG670 Configuration examples for injection based protection functions

Introduction

This application note will provide configuration examples for the injection based protection functions namely 100% stator earth fault protection (STTIPHIZ) and sensitive rotor earth fault protection (ROTIPHIZ). The example shall cover the application configuration and settings.

The actual hardware connection between the REG670 and injection equipment units, installation, commissioning and calibration will not be part of this application note rather it can found in the REG670 Installation and commissioning manual 1MRK502029-UEN.

For the detailed connection diagrams, we recommend that the drawings 1MRK002504-BA, 1MRK002504-CA, and 1MRK002504-DA are referred. These are available as part of the REG670 Technical reference manual 1MRK 502 027-UEN section 21.

1 Application configuration

In this section the application configuration examples for the various modes will be described. The various modes are:

Separate: Where four separate voltage inputs are used, two for stator and two for rotor. This is shown as Alternative #3, in 1MRK002504-BA page 5. This is the recommended method when both injection based protection functions are used and it gives the best measurement accuracy.

Mixed: Where two voltage inputs are used, both stator and rotor combined. This is shown as Alternative #4, in 1MRK002504-BA page 5. This method shall be used when both injection based protection functions are used and there is a limitation of only two VT inputs available in the REG670. This method can cause loss in measurement accuracy for both injection based protection functions.

Either: Where two voltage inputs are used, either for stator or rotor. This is shown as Alternatives #1 & #2, in 1MRK002504-BA page 5. As only one injection based protection function (stator or rotor) is used with specific voltage inputs, this method gives the best measurement accuracy for a single injection based protection function.

1.1 Connection of voltage channels, pre-processing, separate

The Figure 1 shows the connection between the REX060 to the REG670 VT inputs when using the stator and rotor earth fault functions in a separate mode (using four voltage channels). As can be seen, four voltage channels are used, one set for the stator function and another set for the rotor function.

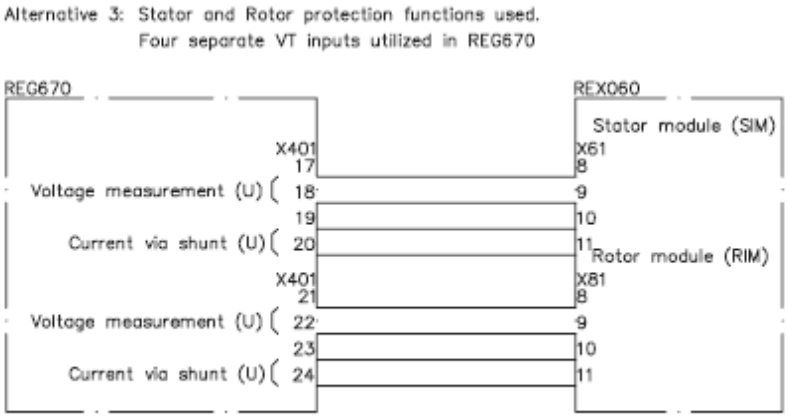

Figure 1: Connection of REX060 to REG670 VT inputs, separate

The Figure 2 shows the application configuration when using the stator and rotor earth fault functions in a separate mode (using four voltage channels). As can be seen, four voltage channels are used, one set for the stator function and another set for the rotor function. The **S-U Inject** is obtained by a galvanic connection of U_A U_B REX060:X61:8,9 and the **S-U(I) Inject** is obtained by a galvanic connection of I_A I_B REX060:X61:10,11 from the SIM module (figures 40 in 1MRK502029-UEN). Similarly, the **R-U Inject** is obtained by a galvanic connection of U_A U_B REX060:X81:8,9 and the **R-U(I) Inject** is obtained by a galvanic connection of I_A I_B REX060:X81:10,11 from the RIM module (figures 41 in 1MRK502029-UEN).

The separate signals shall be connected to separate pre-processing functions SMAIs and then to the **USU** and **USI** inputs of the stator (STTIPHIZ) and rotor (ROTIPHIZ) functions as shown in Figure 2.

Note: It is vital that the SMAI instances are on 8ms for the functions to work correctly.

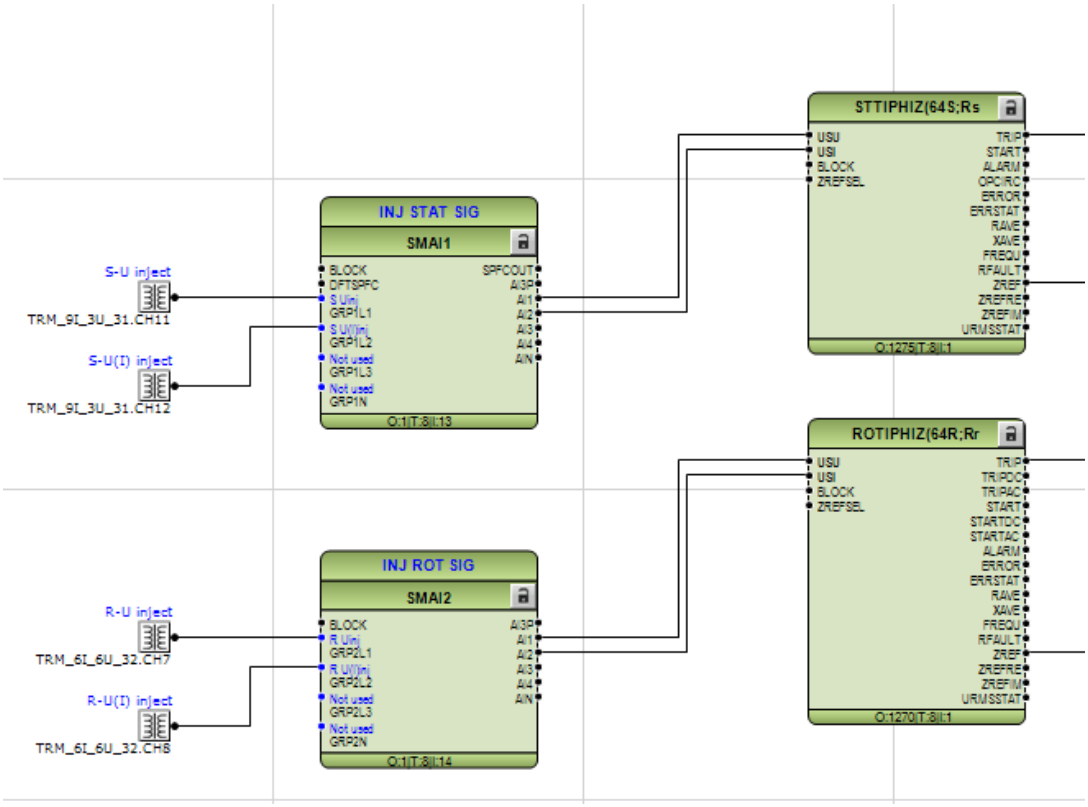

Figure 2: Connection of voltage channels, pre-processing, separate

1.2 Connection of voltage channels, pre-processing, mixed

The Figure 3 shows the connection between the REX060 to the REG670 VT inputs when using both the stator and rotor earth fault functions in a mixed mode (using two voltage channels). As can be seen, two voltage channels are used, one for the injected voltage and another for the injected current (measured as a voltage across a shunt).

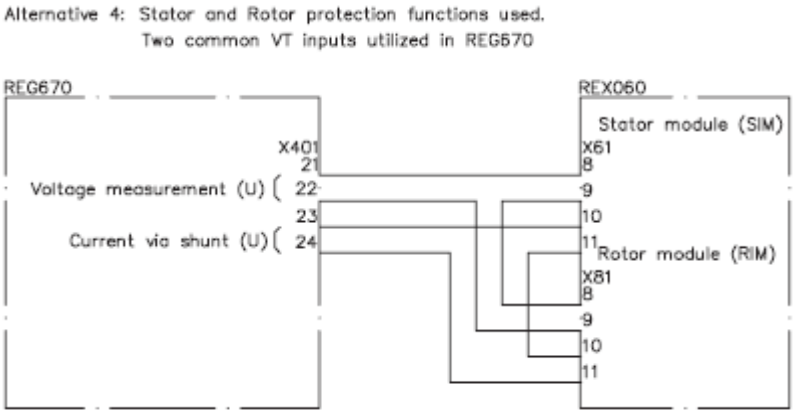

Figure 3: Connection of REX060 to REG670 VT inputs in series

The Figure 4 shows the application configuration when using both the stator and rotor earth fault functions in a combined mode (using two voltage channels). As can be seen, two voltage channels are used, one for the injected voltage and another for the injected current (measured as a voltage across a shunt). The mixed **U Injected** is obtained by a galvanic connection of U_A REX060:X61:8 and U_B REX060:X81:9 from both the SIM and RIM modules connected in series (figures 40 and 41 in 1MRK502029-UEN). Similarly, the mixed **U(I) Injected** is obtained by a galvanic connection of I_A REX060:X61:10 and I_B REX060:X81:11 from both the SIM and RIM modules connected in series (figures 40 and 41 in 1MRK502029-UEN).

The **U Injected** shall be connected via the pre-processing function SMAI to the **USU** input of the stator (STTIPHIZ) and **USU** input of the rotor (ROTIPHIZ) functions. Similarly the **U(I) Injected** shall be connected via the pre-processing function SMAI to the **USI** input of the stator (STTIPHIZ) and **USI** input of the rotor (ROTIPHIZ) functions.

Note: It is vital that the SMAI instance is on 8ms for the functions to work correctly.

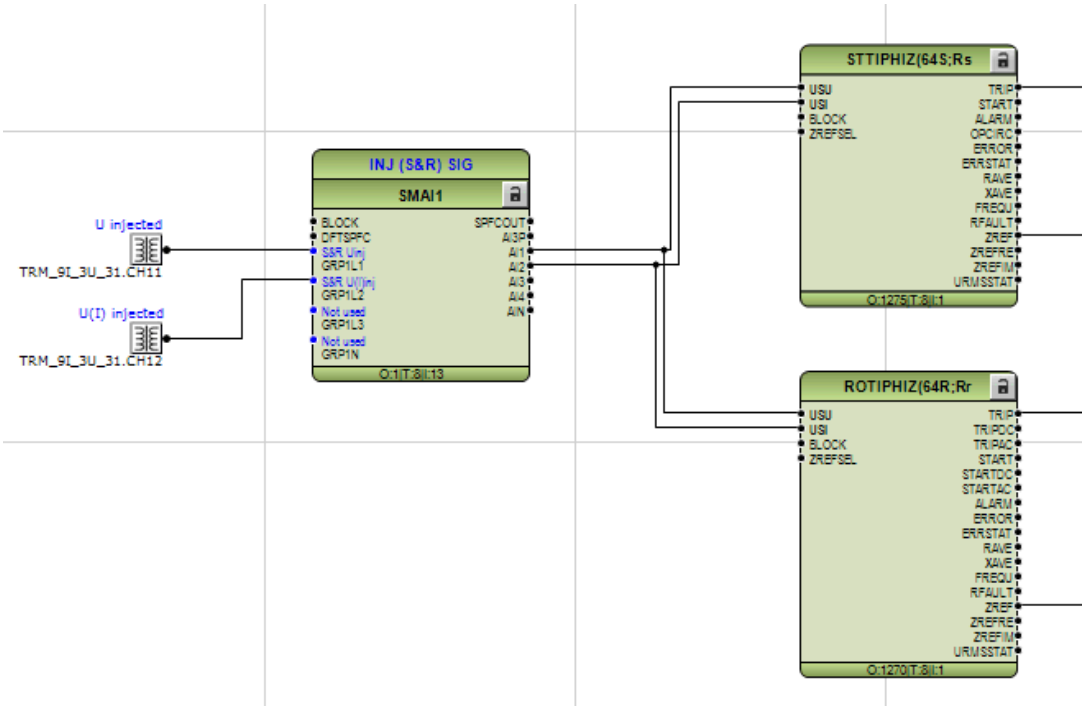

Figure 4: Connection of voltage channels, pre-processing, mixed

1.3 Connection of voltage channels, pre-processing, either rotor or stator

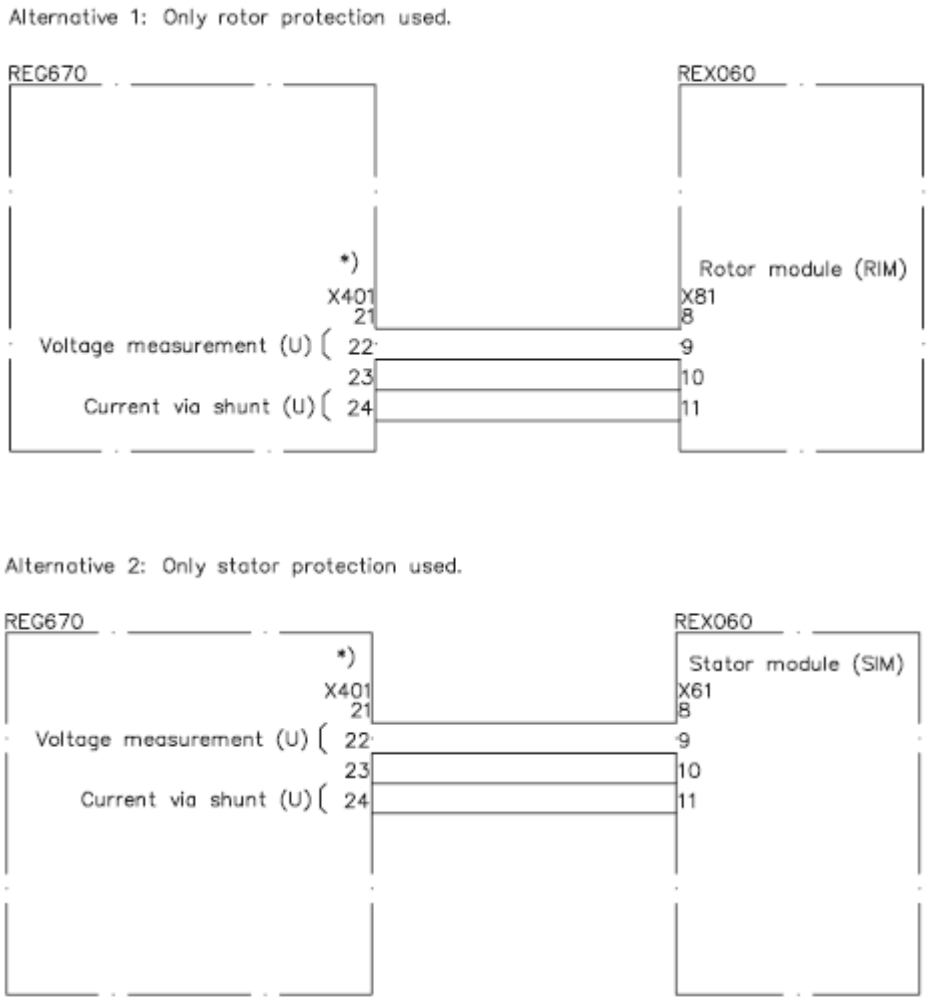

Figure 5: Connection of REX060 to REG670 VT inputs (either one)

If only rotor or stator injection based protection function (any one only) needs to be configured, then the example in section 2.1 in this document shall be followed. Only the required pre-processing function block and protection function shall be configured.

1.4 Dynamic reference selection logic

Normally the machine has different operating states (eg. Standstill, Machine excited & GenCB open, Machine excited & GenCB closed) and the appropriate reference impedance can be applied dynamically depending on the running condition of the machine. This is done by automatically changing the value to input **ZREFSEL**.

Note: When the input **ZREFSEL** is left unconnected, then the selected reference is always Reference1.

In the example here, the different operating states are:

Ref1 ➔ Machine at standstill or Machine running & Gen NP voltage < **ULimRMS**.

Ref2 ➔ Machine running & terminal voltage > **ULimRMS**.

Ref3 ➔ Machine running & terminal voltage > **ULimRMS** & GenCB closed.

The Stator dynamic reference selection logic is shown below in Figure 6. The output **URMSSTAT** from Figure 7 (variable circled **orange**) on the protection function STTIPHIZ gives the status of the measured voltage input (injected signal plus the harmonics, typically the 3rd). A setting of **ULimRMS** to about 70V is recommended.

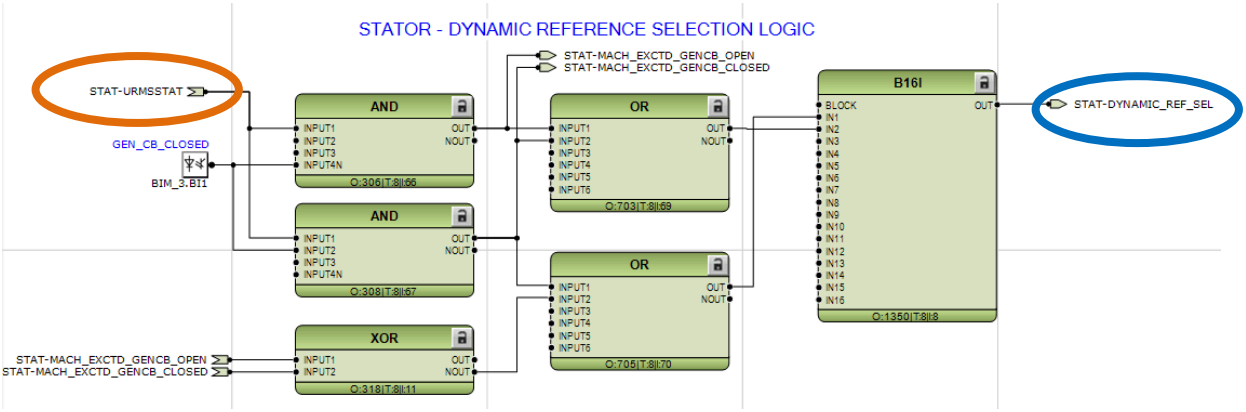

Figure 6: Dynamic reference selection logic for stator (example)

The Stator dynamic reference selection change is shown below in Figure 7. The output from the B16I function Figure 6 (variable circled **blue**) of the logic is connected to the **ZREFSEL** input to dynamically select the reference depending upon the machine operating states.

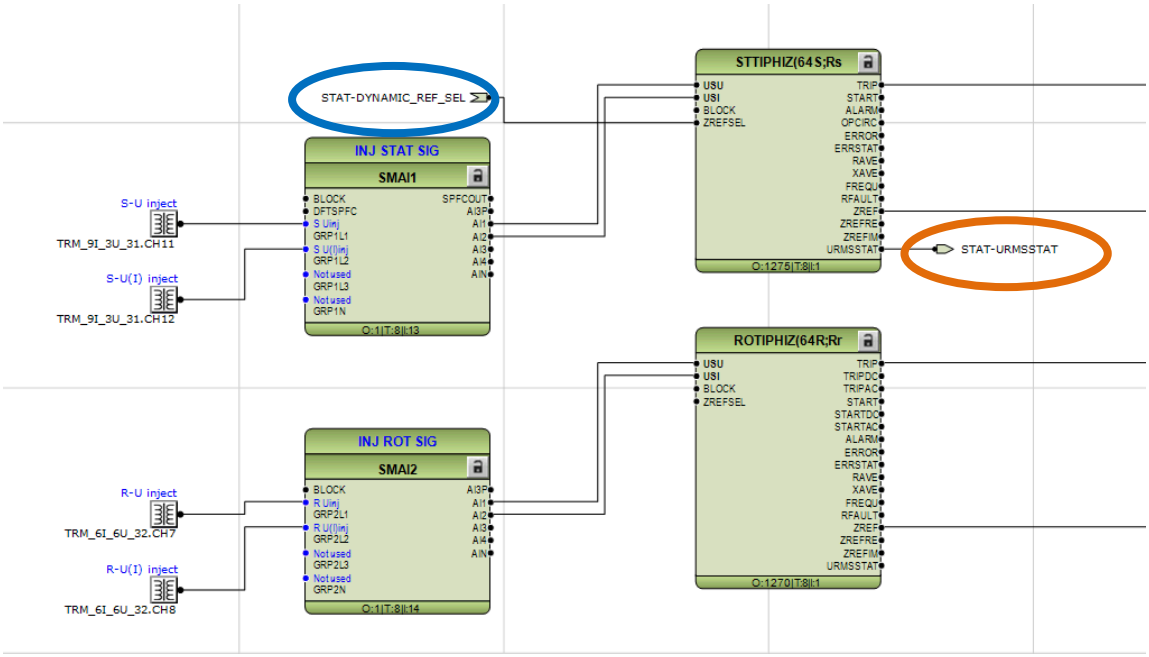

Figure 7: Dynamic reference selection change for stator (example)

A similar logic can be done for the Rotor function too.

Additional conditions if required may be considered, this is an example.

1.5 Other conditions

There are two separate Injection blocked signals available from the REX060 unit, one each from the RIM and SIM modules respectively. These signals can be wired to the binary inputs in the REG670 and used for alarming/indication purposes.

It is also possible to block the injection of signals separately on the RIM and SIM modules from the REX060 unit by activating a binary input on each of them. Typically a blocking logic, tailored to requirement can be configured in the REG670 and this can drive a binary output(s). These binary output(s) can be then wired to the REX060 RIM and SIM modules for blocking the signal injection.

The connections of the outputs TRIP, START, ALARM etc to physical outputs, Trip Matrix function or to LEDs are not shown in this application note. This shall be configured as per the requirement.

2 Parameters and settings

On the HW settings, the TRM voltage channels used for injection shall be set with ratio 1:1 as shown below in Figure 8.

NAMECH11		CH11			13 character(s)
ChannelType11		Voltage			
RatedTrans11		110,0	V	0,1	300,0
VTsec11		100,000	V	0,001	999,999
VTprim11		0,10	kV	0,05	2000,00
NAMECH12		CH12			13 character(s)
ChannelType12		Voltage			
RatedTrans12		110,0	V	0,1	300,0
VTsec12		100,000	V	0,001	999,999
VTprim12		0,10	kV	0,05	2000,00

Figure 8: Settings on the TRM, VT channels in REG670

The following parameters shown in Figure 9 shall be set during commissioning using the ICT tool following the instructions in section 11 in document 1MRK502029-UEN for the stator protection STTIPHIZ.

STTIPHIZ(64S; Rse<): 1			
FilterLength		1 s	
k1Real		10000,000	
k1Imag		500,000	
k2Real		0,000	ohm
k2Imag		600,000	ohm
RefR1		1000,000	ohm
RefX1		2000,000	ohm
RefR2		1000,000	ohm
RefX2		2000,000	ohm
RefR3		1000,000	ohm
RefX3		2000,000	ohm
RefR4		1000,000	ohm
RefX4		2000,000	ohm
RefR5		1000,000	ohm
RefX5		2000,000	ohm

Figure 9: Parameters for stator protection function, STTIPHIZ

The following settings shown in Figure 10 shall also be set for the stator protection STTIPHIZ. The **FreqInjected** is detected by the ICT tool by measuring the exact injected frequency. Therefore this setting shall be written via the ICT ➔ PST.

The settings **RTrip**, **RAlarm** and **tAlarm** for alarm, start and trip activations shall be set in accordance with the desired values for the earth fault functions depending on the requirement and machine conditions.

Setting Group1			
Operation		On	
FreqInjected		87,002	Hz
RTrip		1000	ohm
RAlarm		5000	ohm
tAlarm		30,00	s
OpenCircLim		10000000	ohm
ULimRMS		100	V

Figure 10: Settings for stator protection function, STTIPHIZ

The following parameters shown in Figure 9Figure 11 shall be set during commissioning using the ICT tool following the instructions in section 10 in document 1MRK502029-UEN for the rotor protection ROTIPHIZ.

ROTIPHIZ(64R; Rre<): 1			
FilterLength		1 s	
k1Real		3565,354	
k1Imag		7,372	
k2Real		-999,800	ohm
k2Imag		-15,710	ohm
RefR1		987,345	ohm
RefX1		-110,138	ohm
RefR2		1000000,000	ohm
RefX2		2000,000	ohm

Figure 11: Parameters for rotor protection function, ROTIPHIZ

The following settings shown in Figure 12 shall also be set for the rotor protection ROTIPHIZ. The **FreqInjected** is detected by the ICT tool by measuring the exact injected frequency. Therefore this setting shall be written via the ICT ➔ PST.

The settings **FactACLim**, **tTripAC**, **RTrip**, **RAlarm** and **tAlarm** for alarm, start and trip activations shall be set in accordance with the desired values for the earth fault functions depending on the requirement and machine conditions.

Setting Group1			
Operation		On	
FreqInjected		112,994	Hz
RTrip		1000	ohm
RAlarm		10000	ohm
tAlarm		10,00	s
FactACLim		0,25	
tTripAC		10,000	s
ULimRMS		100	V

Figure 12: Settings for rotor protection function, ROTIPHIZ

3 Testing

Please refer to a separate application note 1MRG005840 “Testing of injection based protection functions” regarding the use of equivalent circuits for the stator and rotor and testing.