

Generator protection REG670

Testing of injection based protection functions

Introduction

This application note will explain the testing of the injection based functions namely 100% stator earth fault protection (STTIPHIZ) and sensitive rotor earth fault protection (ROTIPHIZ) when a machine is not available (e.g., at relay testing, FAT).



Equivalent circuits are suggested for testing and calibration when not connected to the real stator or rotor. With the use of the equivalent circuits, the complete chain can be verified and can be useful for training, Factory Acceptance Testing (FAT) or demonstrations.

The actual hardware connection between the REG670 and REX060 unit is not a part of this application note, rather it can be found in the REG670 installation and commissioning manual 1MRK502029-UEN section 5.5.

The installation, commissioning and calibration is not a part of this application note, rather it can be found in the REG670 Installation and commissioning manual 1MRK502029-UEN sections 10 (Rotor) and 11 (Stator).

Please note that only one function (Rotor or Stator) shall be tested at a time.

1 Application configuration, parameters, settings

Please refer to the application note 1MRG005030 “Configuration examples for injection based protection functions”.

2 Hardware for equivalent Stator circuit

The Figure 1 below shows an equivalent circuit for the stator that can be used for testing purposes.

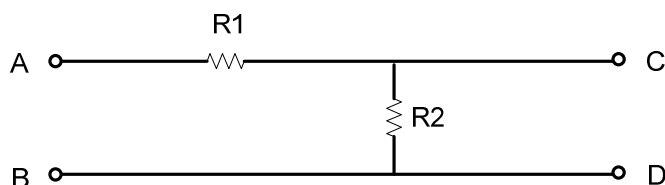


Figure 1: Equivalent circuit for the stator

Resistors $R1=R2=2,2\Omega$ with a minimum rating of 5W each.

The Figure 2 shows the connection of the stator equivalent circuit to the REX060 injection unit. The terminals A:B of the stator equivalent circuit shall be connected to the injection unit REX060 X62:3 & X61:12 and X62:4 & X61:13 (without REX062).

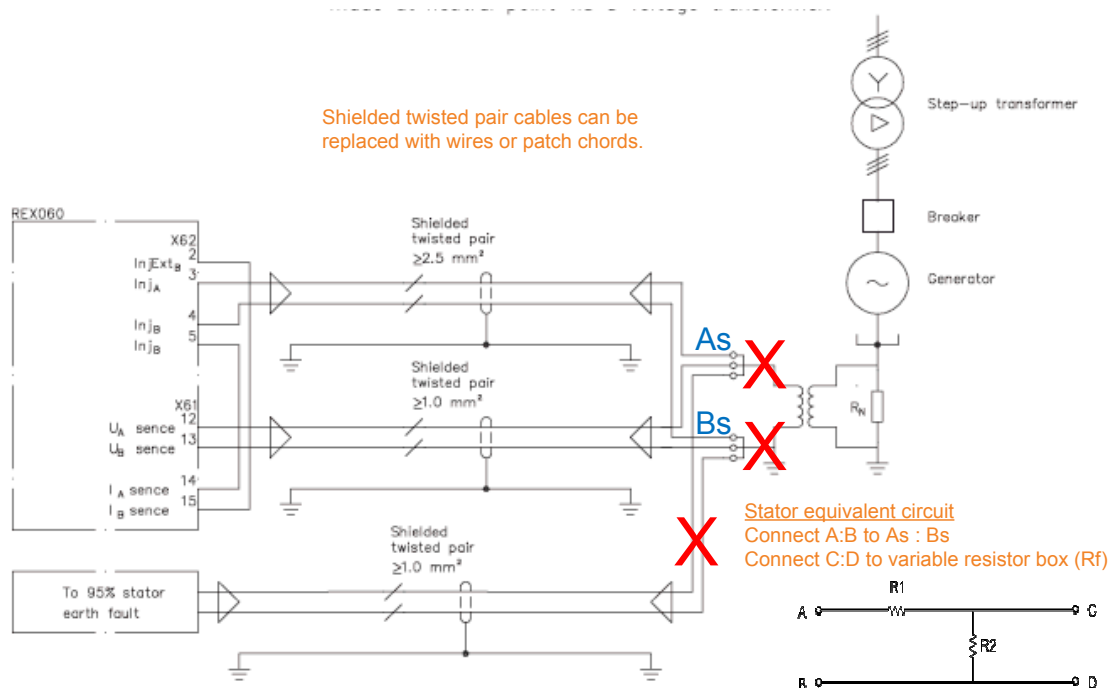


Figure 2: Connection of stator equivalent circuit to the REX060 unit

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

The fault resistance R_f shall be connected across terminals C:D and shall be 1:100 of the actual fault resistance. This is due to the fact that fault seen on the secondary of the voltage or grounding transformer (at generator NP or terminal side) is transformed roughly with the square of the VT turns ratio. This means that if 30Ω is applied across terminals C:D, the function shall see this as a fault of $30 \times 100 = 3k\Omega$.

The settings as shown in the Table 1 below shall be set on the REX060 injection unit for proper functioning with the equivalent circuits.

Setting	Value (50Hz system)	Value (60Hz system)
System f [Hz]	50	60
STATOR f [Hz]	087	103
UmaxEF [V]	240	240
ROTOR f [Hz]	113	137
Gain	1	1

Table 1: Settings on the REX060 injection unit

3 Hardware for equivalent Rotor circuit

The Figure 3 below shows an equivalent circuit for the rotor that can be used for testing purposes.

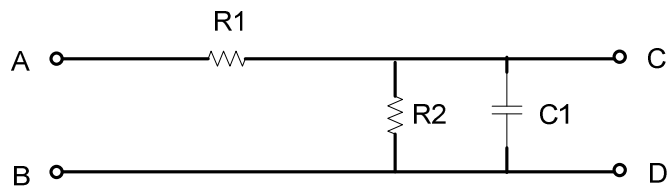


Figure 3: Equivalent circuit for the rotor

Resistors $R1=R2=1k\Omega$ with a minimum rating of 5W each.

Capacitor $C1=150nF$ with a voltage rating $>100V$.

The Figure 4 shows the connection of the rotor equivalent circuit to the REX060 injection unit. The terminals A:B of the rotor equivalent circuit shall be connected to the injection unit REX060 X82:3 and X82:4 (without REX061).

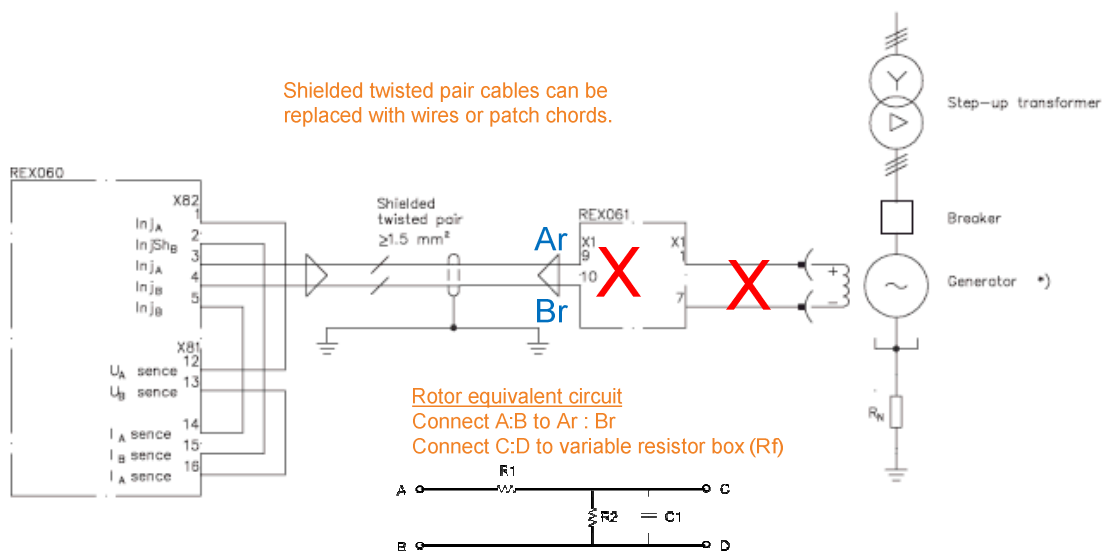


Figure 4: Connection of rotor equivalent circuit to the REX060 unit

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

The fault resistance R_f shall be connected across terminals C:D and shall be 1:1 of the actual fault resistance. This means that if $5k\Omega$ is applied across terminals C:D, the function shall see this as a fault of $5k\Omega$.

The settings as shown in the Table 2 below (identical to Table 1) shall be set on the REX060 injection unit for proper functioning with the equivalent circuits.

Setting	Value (50Hz system)	Value (60Hz system)
System f [Hz]	50	60
STATOR f [Hz]	087	103
UmaxEF [V]	240	240
ROTOR f [Hz]	113	137
Gain	1	1

Table 2: Settings on the REX060 injection unit

4 Testing the 100% stator earth-fault function, injection based

Before the testing is done, the Calibration of the injection based 100% stator earth fault function shall be performed in accordance with section 11, REG670 Installation and commissioning manual 1MRK502029-UEN.

While the actual parameters and settings might differ slightly based on the calibration done with test system used, it will be quite close to the examples shown in Figure 5 and Figure 6 for a 50Hz power system.

✓ STTIPHIZ[64S; Rse<): 1			
✓ FilterLength		1 s	
✓ k1Real		391,718	
✓ k1Imag		-14,732	
✓ k2Real		-238,257	ohm
✓ k2Imag		-8,550	ohm
✓ RefR1		224,477	ohm
✓ RefX1		-1,353	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 5: Parameters, example for STTIPHIZ

✓	Setting Group1			
✓	Operation		On	
✓	FreqInjected		87,000	Hz
✓	RTrip		1000	ohm
✓	RAlarm		5000	ohm
✓	tAlarm		10,00	s
✓	OpenCircLim		10000000	ohm
✓	ULimRMS		100	V

Figure 6: Settings, example for STTIPHIZ

It is recommended that a decade variable resistor box is used for applying the fault resistance R_f across the terminals C:D of the equivalent circuit Figure 1.

Several values can be applied and a linearity check (applied/actual vs. seen on LHMI) can be performed. The table below assumes the settings are according to Figure 6 and the first reference impedance is used.

R_f (Ω) applied (1:100)	R_f (Ω) actual	RFAULT (Ω) seen on LHMI	Comments
No injection	Error	-2000.000	REX060 in OFF position, no injection of signals
Open	Infinite	-1000.000	Infinite or very large resistance to ground
500	~ 50000		Note the value
400	~ 40000		Note the value
:	:		Note the value
40	~ 4 000		This value is below RAlarm therefore, ALARM will be set after tAlarm . Note the value
:	:		Note the value
9	~ 900		This value is below RTrip therefore, TRIP and ALARM will be set. Note the value

Table 3: Values recorded, testing STTIPHIZ

5 Testing the sensitive rotor earth-fault function, injection based

Before the testing is done, the Calibration of the injection based sensitive rotor earth fault function shall be performed in accordance with section 10, REG670 Installation and commissioning manual 1MRK502029-UEN.

While the actual parameters and settings might differ slightly based on the calibration done with test system used, it will be quite close to the examples shown in Figure 7 and Figure 8 for a 50Hz power system.

✓ 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 7: Parameters, example for ROTIPHIZ

✓ Setting Group1			
✓	Operation	On	<input checked="" type="checkbox"/>
✓	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 8: Settings, example for ROTIPHIZ

It is recommended that a decade variable resistor box is used for applying the fault resistance R_f across the terminals C:D of the equivalent circuit Figure 3.

Several values can be applied and a linearity check (applied/actual vs. seen on LHMI) can be performed. The table below assumes the settings are according to Figure 8 and the first reference impedance is used.

R_f (Ω) applied (1:1)	R_f (Ω) actual	RFAULT (Ω) seen on LHMI	Comments
No injection	Error	-2000.000	REX060 in OFF position, no injection of signals
Open	Infinite	-1000.000	Infinite or very large resistance to ground
150k	~ 150k		Note the value
130k	~ 130k		Note the value
:	:		Note the value
9000	~ 9000		This value is below RA larm therefore, ALARM will be set after tA larm. Note the value
:	:		Note the value
900	~ 900		This value is below RTrip therefore, TRIP and ALARM will be set. Note the value

Table 4: Values recorded, testing ROTIPHIZ