FAST BUSBAR TRANSFER SYSTEM

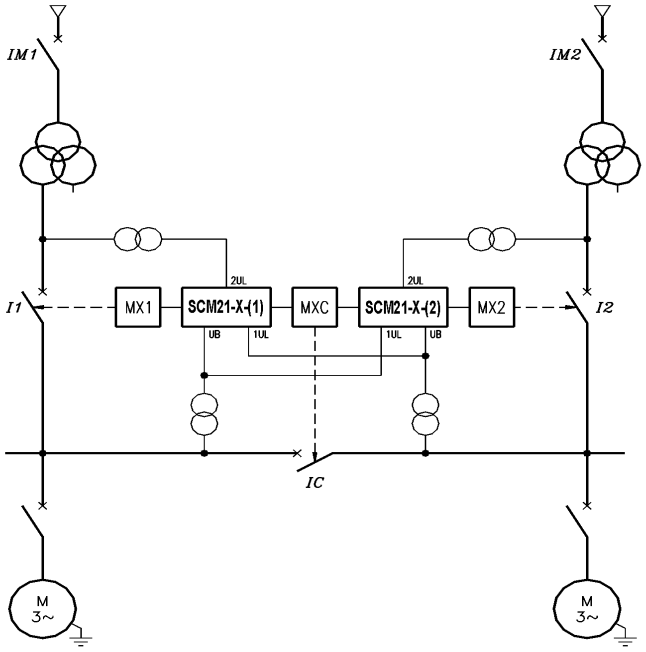
TYPE

SCX-2/3

(no. 2 SCM21-X & no. 3 MX7-5-X)

CE

With reference to the single line diagram herewith included, the device SCX2-3 is capable to control two bus bar systems each feeded by one line with relevant circuit breaker (normally closed) interconnectable by a bus tie breaker normally open.
The system is designed to automatically control the transfer of the bus bar supply from one source to onother one as quickly as possible (about 30ms).



The Fast bus transfer system includes the following modular devices:

1 Relay (**1**) SCM21-X	The synchocheck module dinamically cheks Frequency, Voltage and Phase displacement of the two couples of voltages: Incoming(1)–Bus(1) and Bus(1)-Bus(2).
1 Relay (**2**) SCM21-X	The synchocheck module dinamically cheks Frequency, Voltage and Phase displacement of the two couples of voltages: Incoming(2)–Bus(2) and Bus(2)-Bus(1).
1 Module(MX**1**) MX7-5	C/B control module I1 (Feeder 1)
1 Module (MX**2**) MX7-5	C/B control module I2 (Feeder 2)
1 Module (MX**C**) MX7-5	Bus-Tie C/B control module “Ic”

1. Digital Inputs & Outputs (Fig. 2)

One extenal switch (not supplied) “Aut-0-Man” allow to set the system in Automatic or Manual status:

AUTOMATIC:
- Fast closing C/B Bus-Tie as soon as there is a lack of supply on one of the bus-bars or there is a trip coming from the transformers lock out relays (TF86) of one of the lines. (in case of trip coming from the overcurrent relay, the bus transfer will be blocked)

MANUAL:
- Transfer operation from one line to the other (Bus-tie C/B closure and Feeder C/B opening) takes place by MX7-5 push-button or local command (not supplied).

Each Incoming line control module MX7-5 (I1 and I2) receives, by dry-contacts, the following signals:

Input 1 – Start signal of Automatic transfer from Transformer lock-out relay F86 or SCM21-x Under voltage function
Input 2 – Circuit Breaker Open
Input 3 – Circuit Breaker Closet
Input 4 – C/B closing command
Input 5 – Manual transfer and open C/B command
Input 6 – Bus-Tie C/B Closed
Input 7 – Available

Each Incoming line control module MX7-5 (I1 and I2) sends by its output relays the following commands/ signals:

Relay R1 – Ongoing Transfer signal
Relay R2 – Circuit Breaker position discrepancy signal
Relay R3 – Transfer procedure failure signal
Relay R4 – Circuit Breaker opening Command
Relay R5 – Enable Synchrocheck (UB-2UL check) by closing digital input 3 (Terminals 1-3) of SCM21-X and Incoming line C/B closing command
Relè R6 – Diagnostic relay (normaly energized)

The Bus-Tie module (**C**) MX7-5 receives, by dry-contacts, the following signals:

Input 1 – Start signal of Automatic or Manual transfer from Feeder 1
Input 2 – Bus-Tie C/B Open
Input 3 – Bus-Tie C/B Closed
Input 4 – Bus-Tie C/B closing command from Manual Transfer
Input 5 – Start signal of Automatic or Manual transfer from Feeder 2.
Input 6 – Circuit Breaker “1” Closed
Input 7 – Circuit Breaker “2” Closed

The Bus-Tie module (**C**) MX7-5 sends by the output relays the following commands/signals:

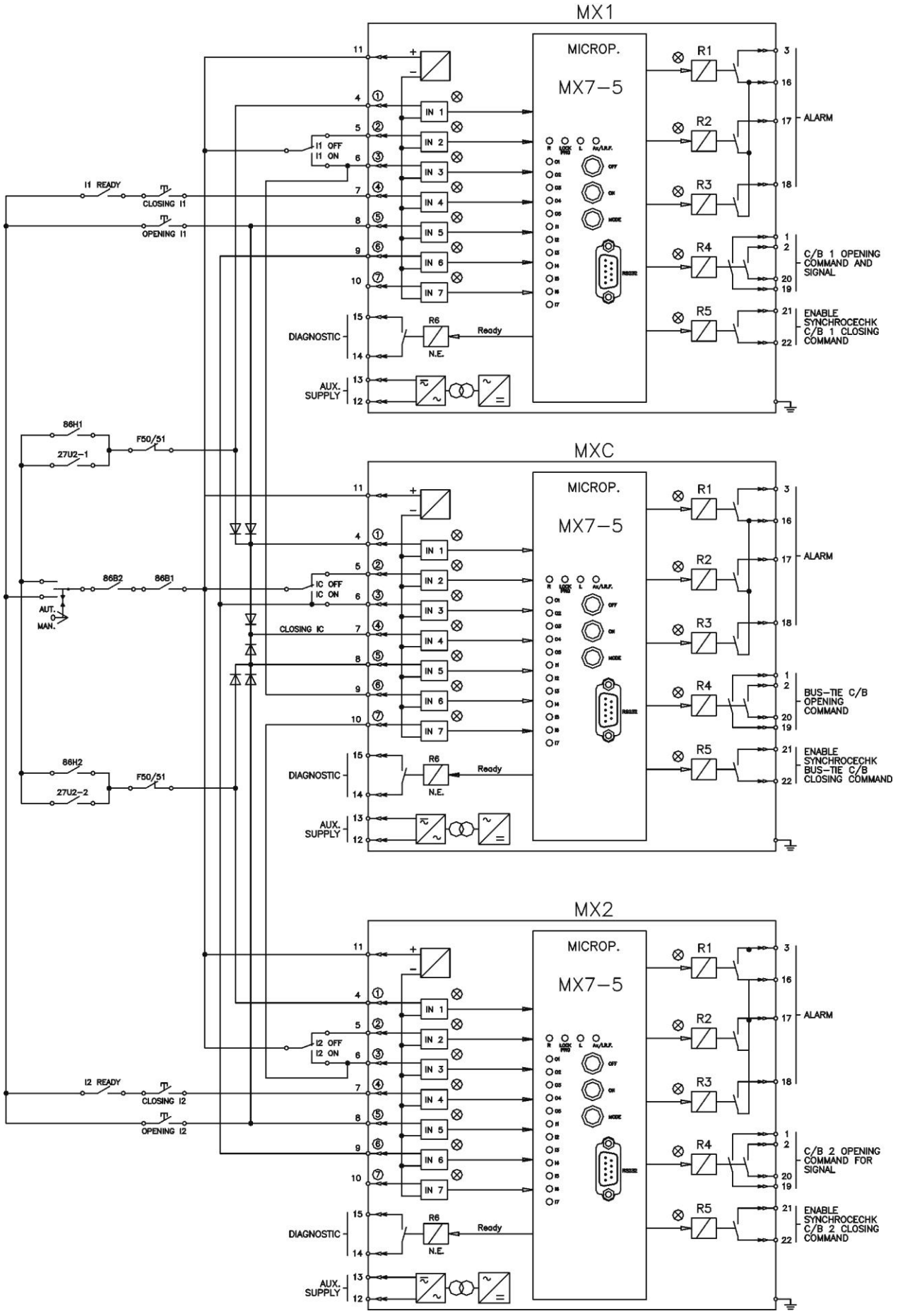
Relay R1 – Ongoing Transfer signal
Relay R2 – Circuit Breaker position discrepancy signal
Relay R3 – Transfer procedure failure signal
Relay R4 – Bus-Tie C/B opening command
Relay R5 – Enable Synchrocheck (UB-1UL check)) by closing digital input 2 (terminals 1-2) of relay SCM21-X and Bus-Tie C/B closing command.
Relay R6 – Diagnostic relay (normaly energized)

Each synchrochek SCM21-X modules, manage the following signals (Fig.5):

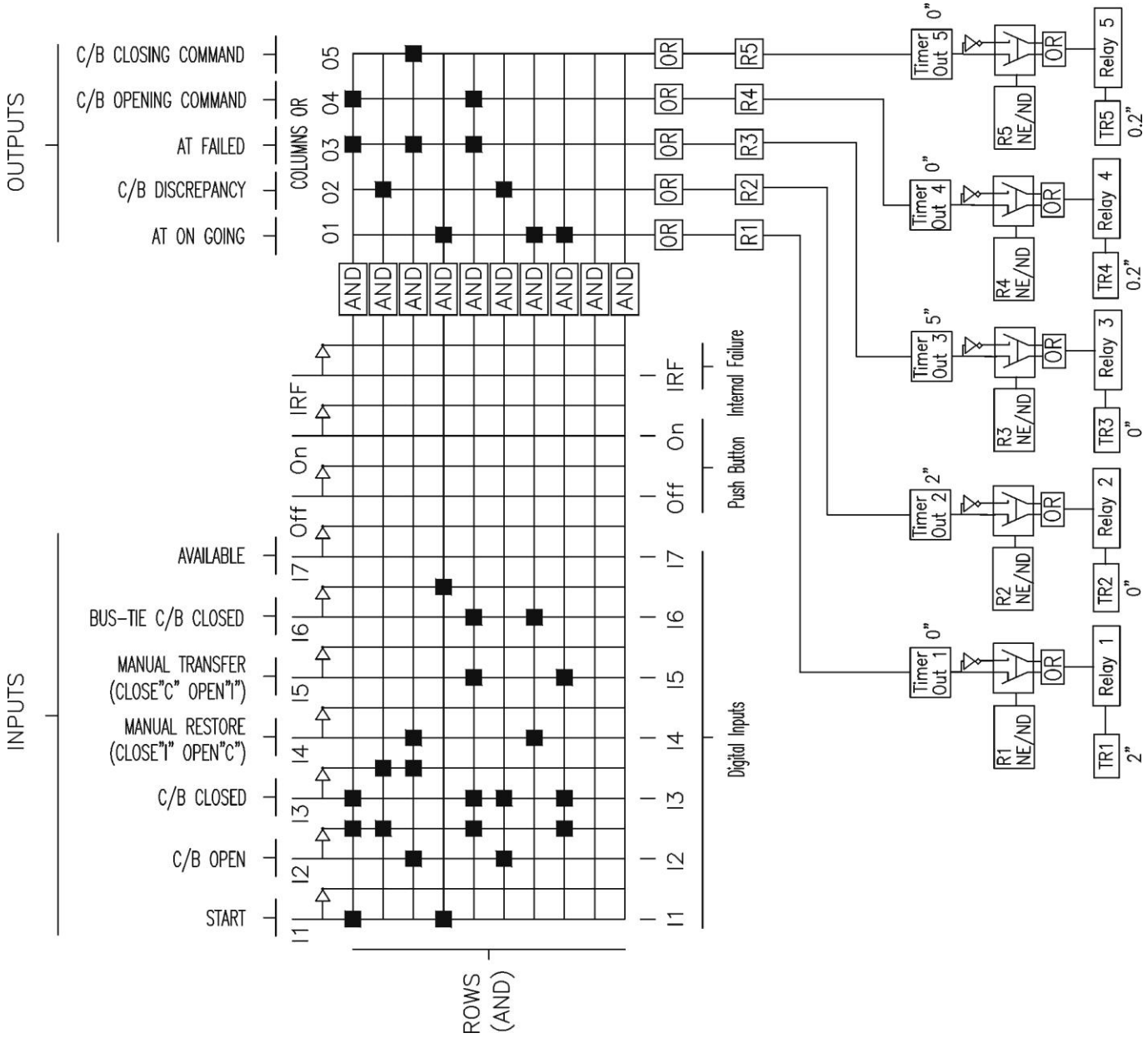
Analogue Input 2UL : Voltage from Incoming Line PT
Analogue Input UB : Voltage from its own bus bar PT
Analogue Input 1UL : Voltage from the other bus bar PT
Digital Input SX1 : Enable Synchrocheck for UB-1UL checking and Bus-Tie C/B closing command
Digital Input SX2 : Enable Synchrocheck for UB-2UL checking and Line C/B closing command
Digital Input BI : Enable Automatic operation (terminals short-circuit).

Output Relay R1 – Undervoltage trip
Output Relay R2 – Bus Tie C/B closing command
Output Relay R3 – Incoming Line C/B closing command
Output Relay R4 – Available
Output Relay R5 – Diagnostic relay (normaly energized)

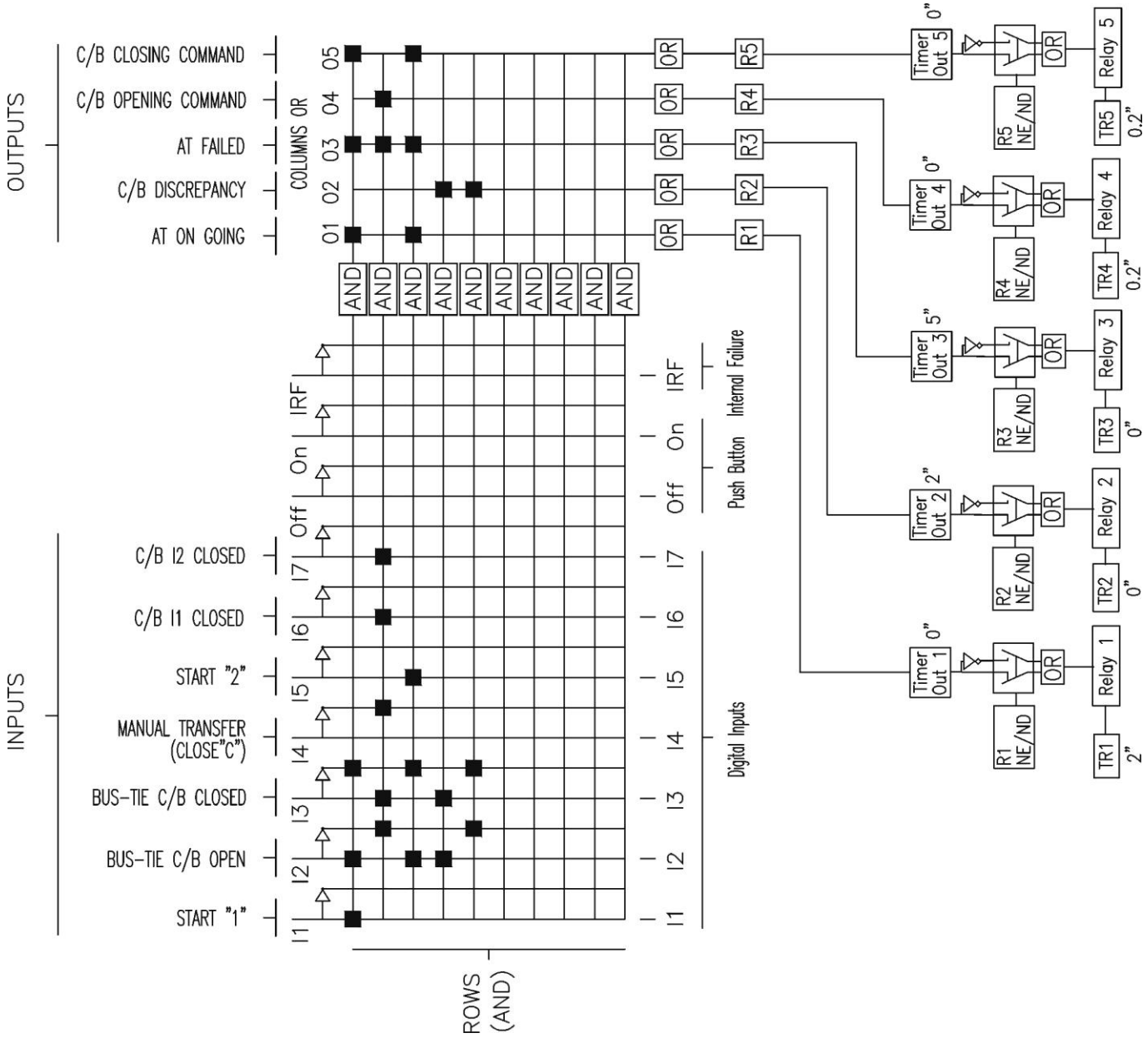
1.1 - Figure 2



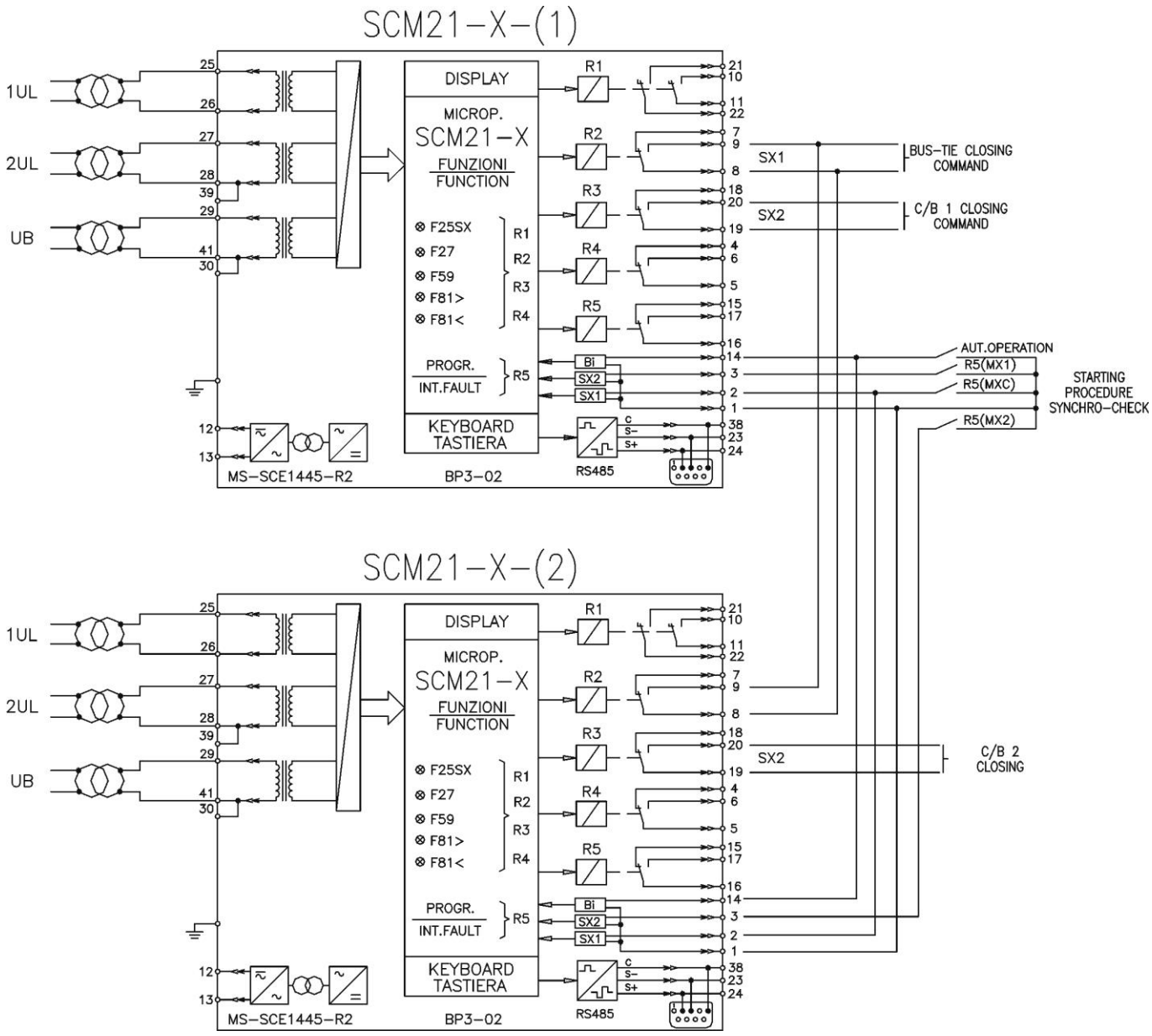
1.2 - Figure 3 – Feeder Circuit Breaker Matrix



1.3 - Figure 4 – Bus-Tie Circuit Breaker Matrix



1.4 - Figure 5


SCM21-X-(1)
1UL
2UL
UB
25
26
27
28
39
29
41
30
12
13
MS-SCE1445-R2
DISPLAY
MICROP.
SCM21-X
FUNZIONI
FUNCTION
⊗ F25SX
⊗ F27
⊗ F59
⊗ F81>
⊗ F81<
R1
R2
R3
R4
PROGR.
INT.FAULT
R5
KEYBOARD
TASTIERA
BP3-02
Bi
SX2
SX1
C
S-
S+
RS485
21
10
11
22
7
9
8
18
20
19
4
6
5
15
17
16
14
3
2
1
38
23
24
SX1
BUS-TIE CLOSING COMMAND
SX2
C/B 1 CLOSING COMMAND
AUT.OPERATION
R5(MX1)
R5(MXC)
R5(MX2)
STARTING PROCEDURE SYNCHRO-CHECK
SCM21-X-(2)
SX2
C/B 2 CLOSING

2. Operation

2.1 – Automatic Control

Switch set in “Automatic” position

- In normal operation both Line Circuit Breakers are Closed whereas the Bus-Tie C/B is open.
- The signal coming from the transformer lock –out relay (F86) or the undervoltage trip coming from SCM121-X module (outpt relay R1) activates the relevant MX7-5 module by its dedicated input (1) which consequently activates the MX7-5 module associated to the bus-tie C/B (input 1 or 5). This module checks the real open status of the incoming line C/B and then energise the R5 relay.
  The R5 Output relay of MX7-5 (C) send the command to the digital input SX1 of the SCM21-X relays and enable the dynamic synchrochek of the two bus-bar voltages.
  If the synchronism conditions are met the SCM21-X energies the R2 output relay which close the bus-tie C/B.

Following four conditions are those which cause the bus-tie closure in AUTOMATIC operation status:

1 - Fast Transfer with phase displacemet below the set value [1α], “ΔU” e “Δf” values are also below the set limits “1ΔU” e “1Δf”.
The C/B closing command is issued taking into account: the C/B closing time [tcb], the frenquency and phase difference (Δfo, αo) -eventually exsisting at the moment of transfer start signal- and finally the frequency variation “Δf/“Δt”

$$\alpha_s = \alpha_o + \Delta f_o\left(t_{cb} + t_c r\right)\cdot 360 + \frac{1}{2}\frac{\Delta f}{\Delta t}\left(t_{cb} + t_{cr}\right)^2 \cdot 360$$

tcr = 0.07sec is the activation time of the output relay contact which command the C/B closure.

Therefore the colsing command is issued if: $\alpha s \leq [1\alpha]$.

2 - If the initial situation is different from the one described above, the closure of the bus-tie C/B takes place at the first phase coincidence of the two voltage signals provided that “ΔU” e “Δf” values are below the set limits “1ΔU” e “1Δf”.
Also in this case the closing command is issued with a proper advance to recover the circuit breaker closing time.

3 - If none of the two above situations is present, the transfer can take place as soon as the busbar residual voltage drops below a set limit [U_R]

4 - Finally, if also the condition at point 3 is not satisfied, the SCX can be programmed to issue the closing command anyhow after a set time [tk].

2.2 – Manual Control

Switch set in “Manual” position

Normally the decision to manually execute the bus transfer is taken for maintanance reasons.
As soon as the start transfer signal is acquired by the digital input terminals 1-2 (SX1) or 1-3 (SX2) the synchrochecks procedures start and the system analise the couples of voltages “BU-1UL“ (SX1) or “BU-2UL“ (SX2) depending on which of the two lines issued the transfer command.
In this operation mode a static condition where the voltages are very stable in module and almost synchronous.
Therefore the device checks the parameters [2ΔU], [2Δf] e [2α] and issue the closing command when following three conditions are satisfied simultaneously:

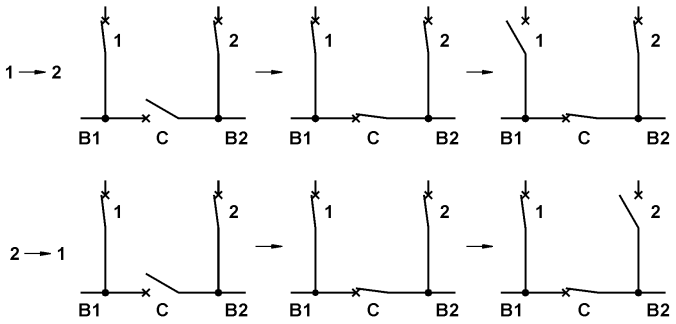
$$\begin{cases} \Delta U < [2\Delta U] \\ \Delta f < [2\Delta f] \\ \Delta \alpha < [2\alpha] \end{cases}$$

Obviously also the conditions relevant to each single volatages must be satisfied.

In this “static” operation it are not taken into account neither the closing time of the circut breaker nor the forced closing command after the set “tk” time.

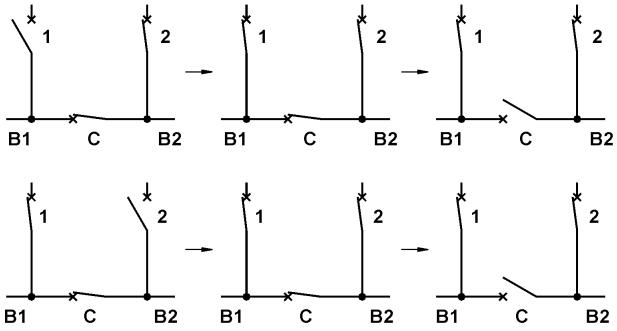
Hereafter are described in details the different transfer phases of this configuration:

A) Bus B1(2) Supply Transfer request from Circuit breaker I1(2) to circuit Breaker I2(1).



The opening command is sent to the input 5 (terminal 8) of MX1(2) and the command is repeated throguh a diode at MX-C inputs; the R5 output relay of MX7-5 module assosiacted to the bus-tie C/B which enable the Synchrocheck of the two bus bars and then the C/B closure. As soon as the closed status signal of C is acknowledged by the digital input 6 (terminal 9) of MX1(2), the outpt relay R4 is energised to open the circuit breaker I1(2)..
If after the set time delay (5”), the circuit breaker C is not closed, the signal of AT failed is issued by energising the R3 output relay of MX-C.

B) Restore request: from B2 and B3 feeded by I2(1) with bus-tie C/B “C” closed to B1 feeded by I1 and B2 feeded by I2 with C open.



The I1(2) closing command is sent through digital input 4 (terminal 7) of MX1(2). MX1(2) Output relay R5 is immediately energised so, if the input 6 (terminal 9) and 7 (terminal 10) of MX-C are both active, close the MX-C R4 output relay which send the opening command to the bus-tie C/B. If after the the set time delay from the closed status signal of I1 and I2, the open status signal of C is not acknowleged, the signal of AT failed is issued by energising the R3 output relay of MX-C.

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