Temat: Gra Reversi

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1. Opis teoretyczny zadania

Celem zadania jest implementacja gry Reversi na sterowniku S7-1200 zgodnie z przyjętymi zasadami. Gra powinna być możliwa do zagrania przez dwóch graczy na urządzeniu HMI a sterownik powinien przechowywać i zapamiętywać wyniki pięciu ostatnich gier oraz tworzyć tabelę pięciu najlepszych wyników wraz z imionami graczy.

2. Podział pracy:

- a. Maciej Dworzański:
- Wybór HMI z dostępnych na stronie Siemens
- Stworzenie interfejsu graficznego wraz z przypisaniem tagów
- Dodanie do algorytmu szukania prawidłowego ruchu systemu wskazówek
- Implementacja pętli systemu wskazówek wraz ze zliczaniem ilości możliwych ruchów
- b. Szymon Feliński:
- Opracowanie i implementacja algorytmu szukania prawidłowego ruchu (obliczanie możliwych indeksów w ośmiu kierunkach)
- Implementacja algorytmu przejmowania pól po wykonaniu ruchu
- Opracowanie i implementacja algorytmu zapisywania wyników do tabeli
- Opracowanie algorytmu resetowania gry, wykrywania zwycięstwa, zmiany gracza w przypadku braku możliwych ruchów i końca gry
- Implementacja systemu zliczania punktów

3. Opis istniejących rozwiązań

W grę "Reversi" możemy zagrać na wielu różnych urządzeniach. Możemy ją znaleźć m.in. na Sklepie Play¹ i pobrać wersję na Androida. W Microsoft Store znajduje się wersja na Windowsa. Istnieje też dużo wersji przeglądarkowych (np. na stronie topster.pl² albo kurnik.pl³).

4. Algorytm (schematy blokowe)

Przyjęto konwencję nazw:

- Zmienne lokalne i wejścia/wyjścia rozpoczynają się od #
- Tylko pierwsze słowo w nazwie zmiennej jest kapitalizowane
- Zmienne zapisane w Data Bloku rozpoczynają się od %DB1.
- Każde słowo w nazwie bloków funkcyjnych jest kapitalizowane
- Nazwy bloków funkcyjnych w opisach są uzupełnione odpowiadającymi im adresami w sterowniku (FB1..14)
- Zapis #Nazwa(1:3) oznacza zmienne lokalne w kolejności: #Nazwa1, #Nazwa2, #Nazwa3
- Zapis #Nazwa(#i-2) gdy #i=5 oznacza zmienną lokalną #Nazwa3

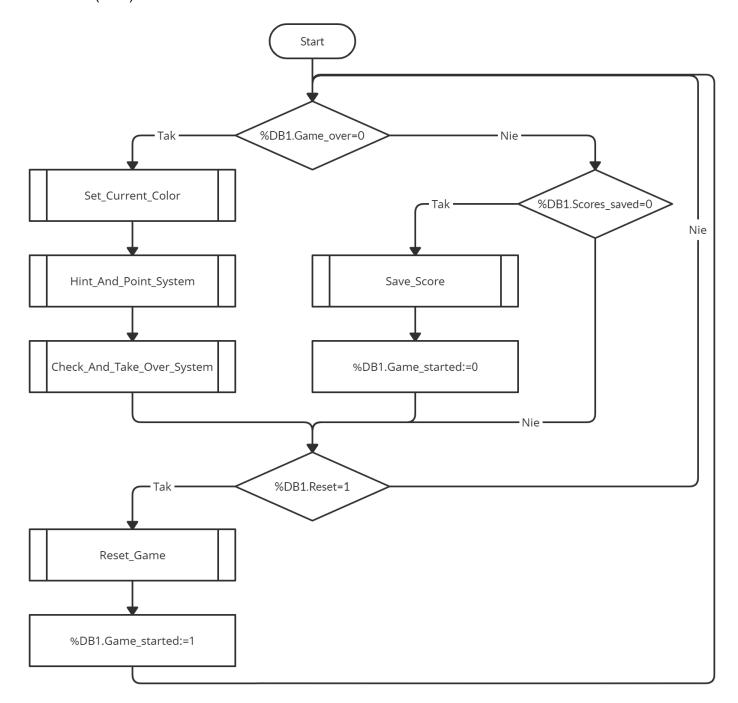
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¹ https://play.google.com/store/apps/details?id=uk.co.aifactory.rrfree&hl=pl&gl=US

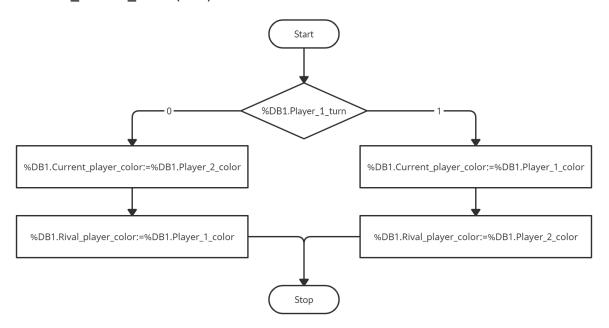
² https://www.topster.pl/reversi/

³ https://www.kurnik.pl/reversi/

• Main (OB1):

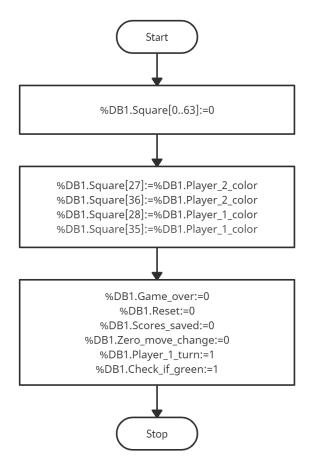


• Set_Current_Color (FB8):



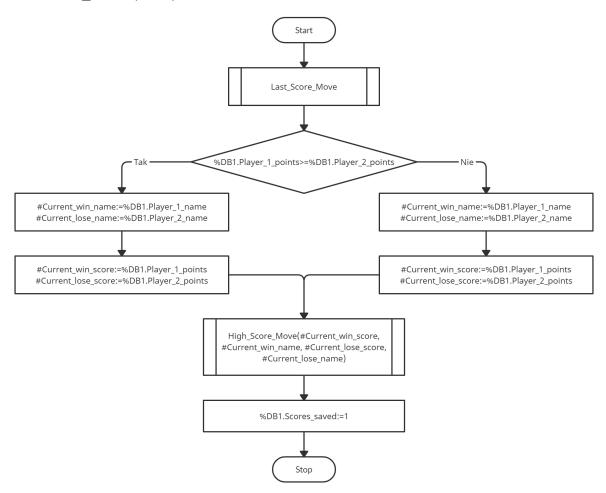
Ten blok funkcyjny ustala odpowiednie kolory obecnego gracza i przeciwnika na podstawie zmiennej Player_1_turn.

• Reset_Game (FB13):



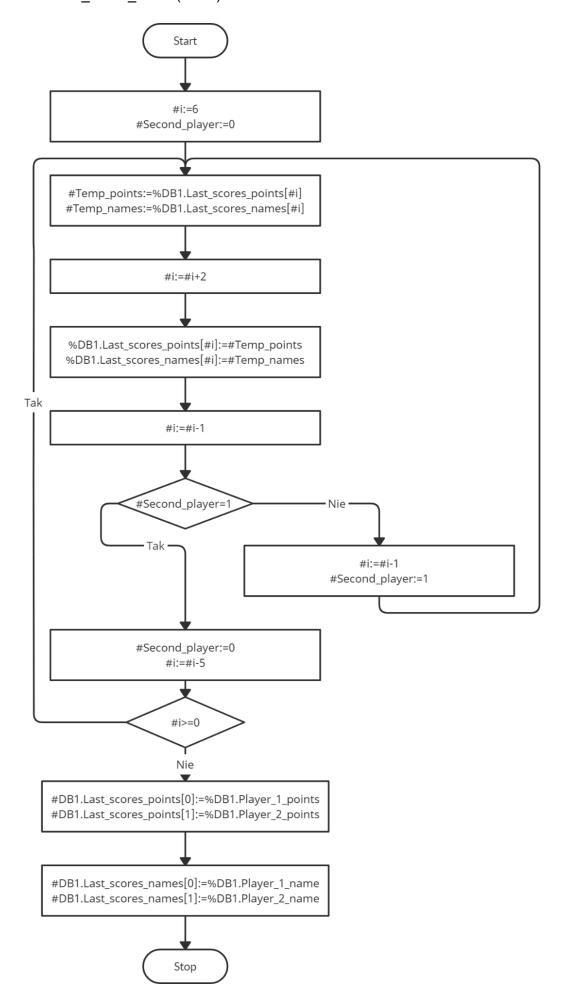
Ten blok funkcyjny zeruje tablicę z planszą, wpisuje kolory graczy (początkowe piony) i ustala zmienne logiczne tak, aby rozpocząć od nowa grę.

Save_Score (FB11):



Warto zauważyć, że w przypadku remisu gracz 1. będzie uznany za zwycięzcę.

• Last_Score_Move (FB12):



Blok funkcyjny Last_Score_Move (FB12) zapisuje wyniki ostatniej gry na początek tablic Last_scores_points oraz Last_scores_names bez względu na to, kto wygrał mecz, jednocześnie przesuwając poprzednie cztery gry o jedno miejsce w dół w tabeli (ostatni jest odrzucany).

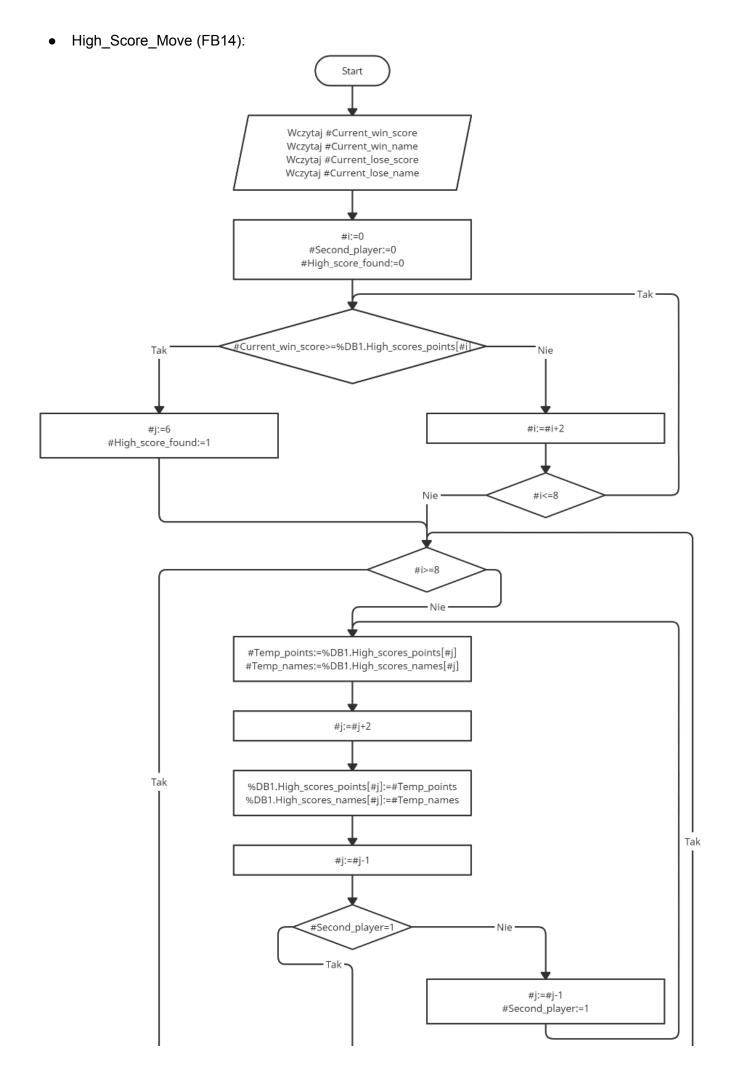
Gra		Player 1	Player 2	
	1	0		1
	2	2		3
	3	4		5
	4	6		7
	5	8		9

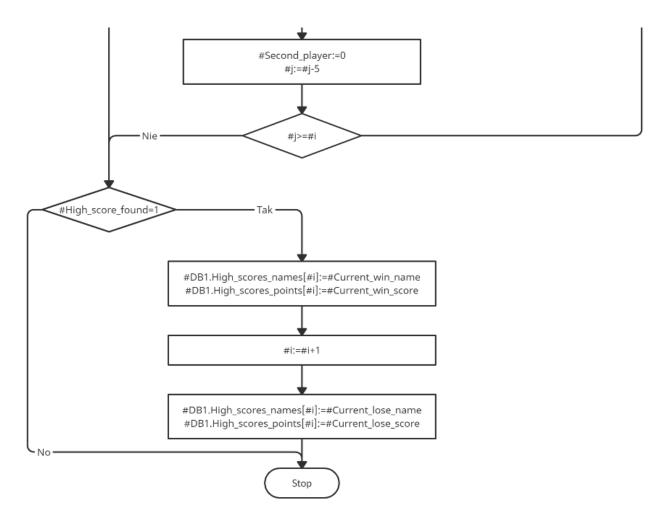
Przed:			
Gra		Player 1	Player 2
	1	5	7
	2	32	32
	3	60	4
	4	15	40
	5	33	31

Po:	o: Obecna gra: 16-30					
Gra	Player 1	Player 2				
1	16	30				
2	5	7				
3	32	32				
4	60	4				
5	15	40				

W komórkach tabeli zapisano indeksy tablic.

Na grafice pokazano przykładowy efekt działania algorytmu. Indeksy tablic z punktami i nazwami są tożsame.





Przykładowy efekt działania algorytmu został przedstawiony na grafice:

Gra		Player 1	Player 2
	1	0	1
	2	2	3
	3	4	5
	4	6	7
	5	8	9

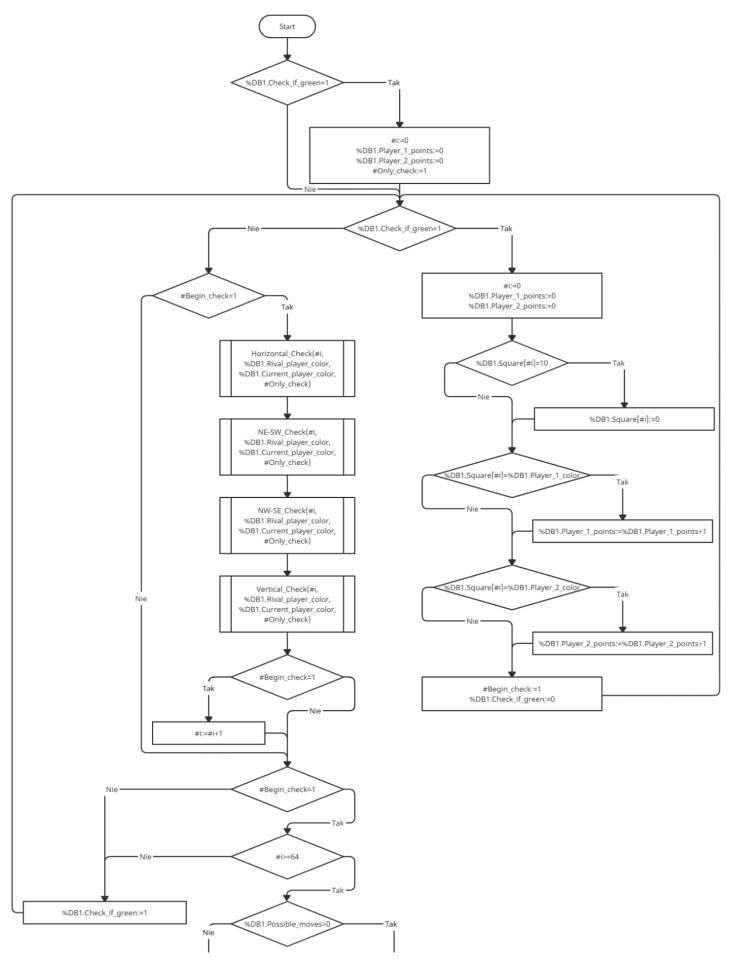
Przed:			
Gra		Player 1	Player 2
	1	60	4
	2	40	15
	3	33	31
	4	32	32
	5	7	5

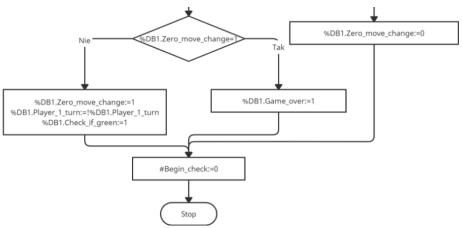
Po:	o: Obecna gra: 16-36					
Gra	P	layer 1	Player 2			
1		60	4			
2	2	40	15			
3	3	36	16			
4	ŀ	33	31			
	,	32	32			

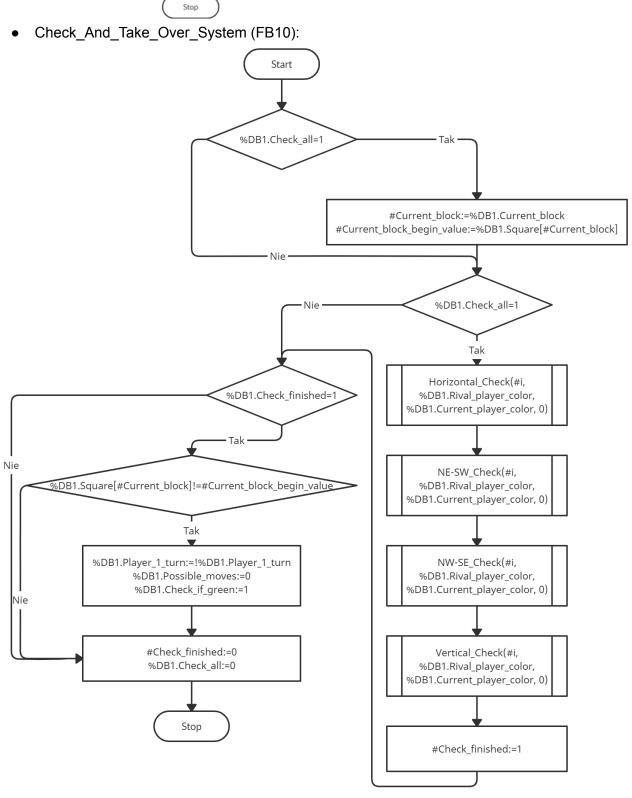
W komórkach tabeli zapisano indeksy tablic.

Blok funkcyjny High_Score_Move (FB13) zapisuje wyniki ostatniej gry do odpowiedniego miejsca w sortowanej po wartości w indeksach parzystych, mając na wzgląd to, kto wygrał mecz. Jeśli ilość punktów z ostatniej gry jest wyższa niż którykolwiek wynik z pierwszej kolumny, to wynik ten jest wstawiany pod ostatni wynik wyższy od obecnego, jednocześnie przesuwając wyniki niższe o jedno miejsce w dół (ostatni jest odrzucany).

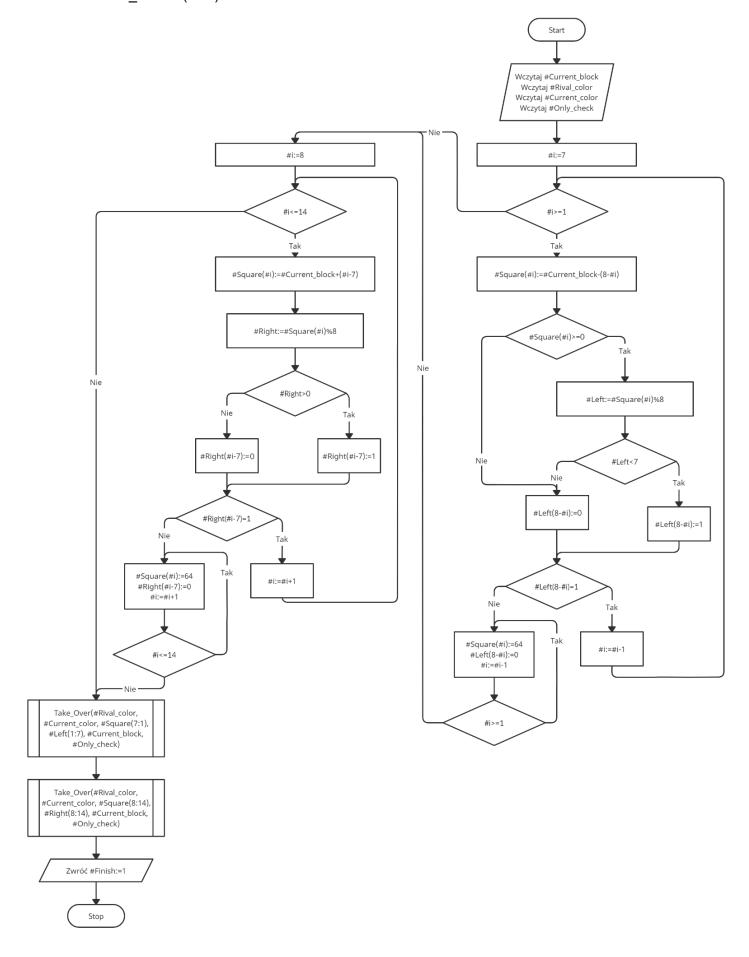
• Hint_And_Point_System (FB9):



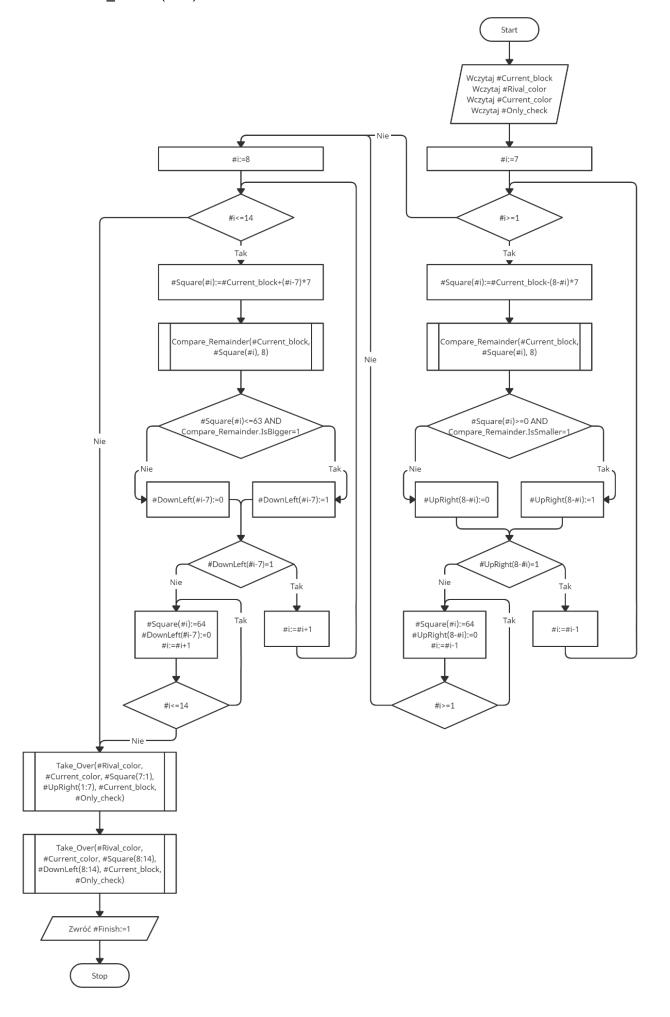




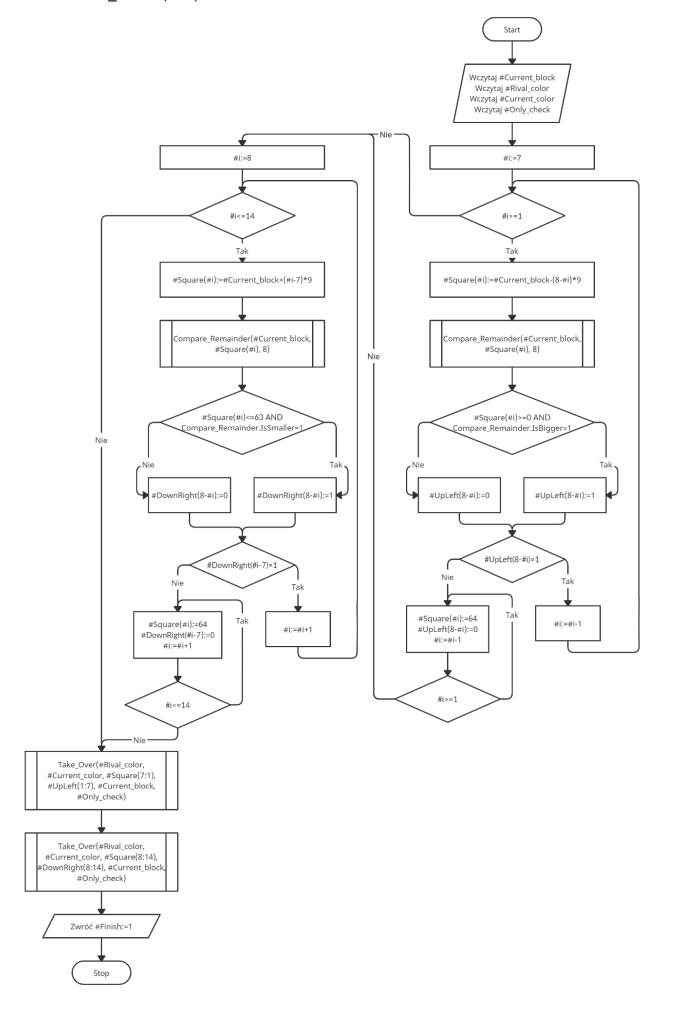
• Horizontal_Check (FB3):



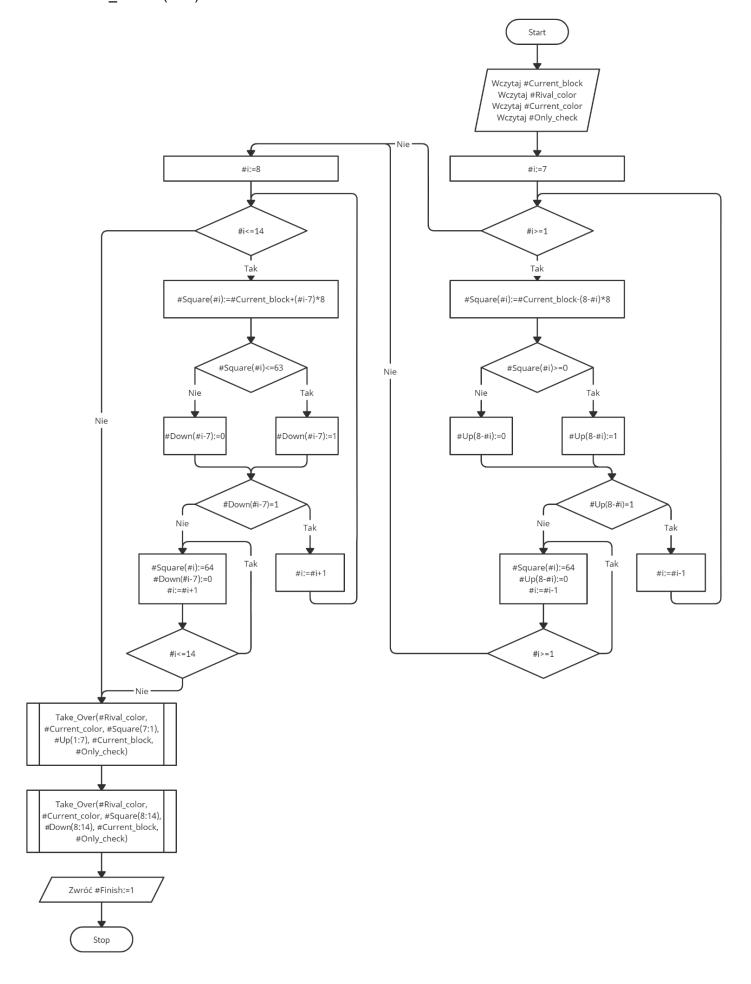
• NE-SW_Check (FB5):



• NW-SE_Check (FB4):



• Vertical_Check (FB1):



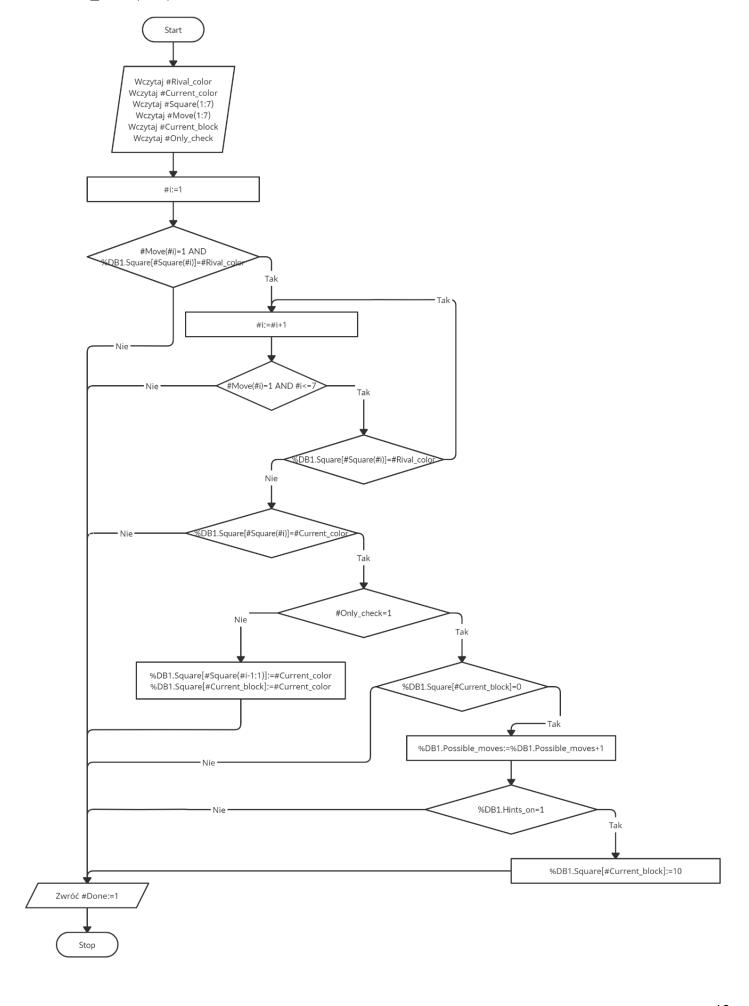
Graficzne przedstawienie tablicy Square[] i możliwych wyliczeń indeksów w blokach _Check:

Square[0..63]

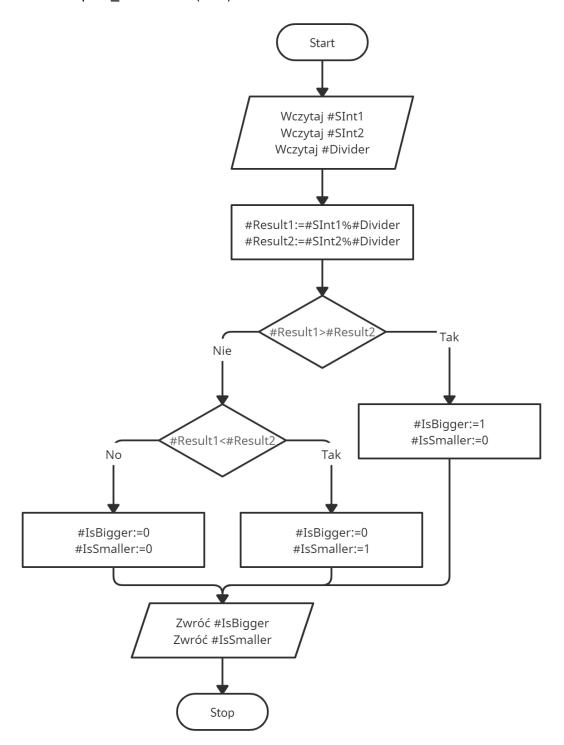
adam afamaal								
0	1	2	3	4	5	6	7	
8	9	10	11	12	13	14	15	
16	17	18	19	20	21	22	23	
24	25	26	27	28	29	30	31	
32	33	34	35	36	37	38	39	
40	41	42	43	44	45	46	47	
48	49	50	51	52	53	54	55	
56	57	58	59	60	61	62	63	

_														
-63							-56							-49
	-54						-48						-42	
		-45					-40					-35		
			-36				-32				-28			
				-27			-24			-21				
					-18		-16		-14					
						-9	-8	-7						
-7	-6	-5	-4	-3	-2	-1	i	1	2	3	4	5	6	7
						7	8	9						
					14		16		18					
				21			24			27				
			28				32				36			
		35					40					45		
	42						48						54	
49							56							63

• Take_Over (FB2):



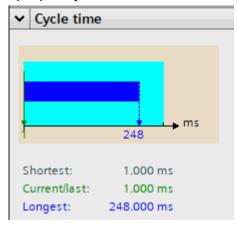
• Compare_Remainder (FB7):

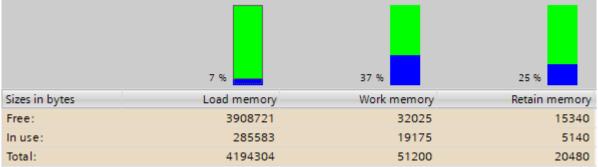


Do zaprogramowania urządzeń, implementacji algorytmów i symulacji wykorzystano oprogramowanie TIA Portal V16, WinCC Advanced V16, PLCSIM V16.

Name	Version	Release
Automation License Manager	V6.0 + SP5 + Upd1	06.00.05.01_02.01.00.05
S7-PCT	V3.5 + SP1	K3.5.1.0_1.19.0.1
S7-PLCSIM	V5.4 + SP8	V05.04.08.01_01.24.00.01
SIMATIC ProSave	V16.0	V16.00.00.00_31.02.00.01
SIMATIC S7-PLCSIM	V16.0	V16.00.00.00_31.00.13.01
SIMATIC STEP 7 Prof - STEP 7 Safety - WinCC Adv	V16.0	V16.00.00.00_31.02.00.01
SIMATIC WinCC Runtime Advanced Simulation	V16.0	V16.00.00.00_31.02.00.01
TIA Administrator	V1.0	01.00.02.00_01.10.00.01
TIA Portal Project Server	V16.0	V16.00.00.00_31.02.00.01
User Management Component	V2.7	V02.07.00.00_00.00.00.00

5. Spis pamięci sterownika





6. Wnioski

- Projektowanie HMI w programie TIA Portal jest bardzo intuicyjne, połączenie zmiennych używanych w sterowniku z tymi używanymi w panelu jest łatwe.
- Robienie prostych animacji w panelu operatorskim nie wymaga dużej wiedzy, ponieważ program ma do tego wbudowane funkcje.
- Przez cały cykl tworzenia programu zwracaliśmy uwagę na czas pojedynczego cyklu. Program był na bieżąco optymalizowany, aby nie wymagał dużej ilości obliczeń (które mogły mieć miejsce ze względu na dużą ilość pętli "for"). Najdłuższy cykl występuje przy uruchamianiu samego sterownika, potem długość cyklu nie przekracza 4ms.
- Gra została rozbudowana o wybór koloru na początku, w oryginalnej wersji występują jedynie piony czarne i białe.
- Tworząc program tego typu należy uważać na tworzenie tablic danych, próba odwołania się do elementu tablicy, który nie istnieje spowoduje błąd w PLC (miganie czerwonej diody ERROR).
- Wielojęzyczność jest wbudowana w program TIA Portal, więc tworzenie programu w kilku językach jest łatwe.
- Dzielenie programu na podprogramy i umieszczanie ich w osobnych blokach (szczególnie fragmentów programu używanych wielokrotnie) pomaga w organizacji pracy i w debugowaniu.

7. Listing programu i spis tagów:

|--|

Program blocks

Main [OB1]

Main Properties							
General							
Name	Main	Number	1	Туре	ОВ	Language	LAD
Numbering	Automatic						
Information							
Title	"Main Program Sweep (Cy-cle)"	Author		Comment		Family	
Version	0.1	User-defined ID					

Name	Data type	Default value	Comment	
▼ Input				
Initial_Call	Bool		Initial call of this OB	
Remanence	Bool		=True, if remanent data are available	
Temp				
Constant				

Network 1:

Sets current player colors (important when current player changes)

```
"Data_block_
1".Game_over

EN

*DB12

"Set_Current_
Color_DB"

"FBB

"Set_Current_Color"

EN

EN

*FBB
```

Network 2:

Calculates points and possible moves, sets hints

```
"Data_block_
1".Game_over

EN

"Data_block_
EN

"Bata_block_
BENO

"Bata_block_
BENO

"Hint_And_Point_System"

EN

EN

"Bata_block_
BENO
```

Network 3:

System for taking over squares after a move has happened

```
"Check_And_
Take_Over_
System_DB"

"Data_block_
1".Game_over

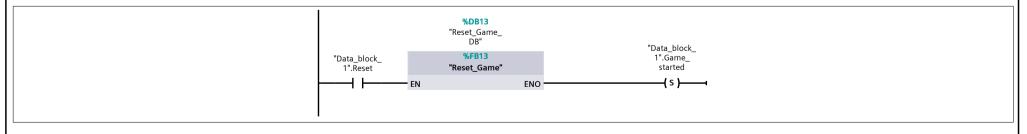
EN ENO
```

Network 4: Default false; tells the PLC that a game is in progress

If game has ended save current scores in respectable arrays. Tell the PLC that a game is not in progress

Network 5: Default false; tells the PLC that a game is in progress

Reset game if the button in HMI is pressed. Tell the PLC that no game is in progress



Totally Integrated
Automation Portal

Program blocks

Data_block_1 [DB1]

Data_block_1 P	roperties									
General										
Name	Data_block_1	Number	1		Туре)B		Langua	i ge D	В
Numbering	Automatic		·							
Information										
Title		Author			Comment			Family		
Version	0.1	User-defi	ined ID							
Name	Data t	ype St	tart value	Retain	Accessible Writ	- Visible in	Setpoint	Supervi-	Comment	

rsion 0.1	User-defined ID							Family	<u> </u>
me	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment
Static	10.01.4		T	T	T	- .	E.L.		According to Electronic Inc.
▼ Last_scores_names	Array[09] of String		True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[0]	String	11	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[1]	String	П	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[2]	String	11	True	True	True	True	False		Array of up to 5 last game player names
Last_scores_names[3]	String	11	True	True	True	True	False		Array of up to 5 last game player
Last_scores_names[4]	String	11	True	True	True	True	False		names Array of up to 5 last game player
Last_scores_names[5]	String	11	True	True	True	True	False		names Array of up to 5 last game player
Last_scores_names[6]	String	П	True	True	True	True	False		names Array of up to 5 last game player
Last_scores_names[7]	String	11	True	True	True	True	False		names Array of up to 5 last game player
Last_scores_names[8]	String	11	True	True	True		False		names Array of up to 5 last game player
		11							names
Last_scores_names[9]	String		True	True	True		False		Array of up to 5 last game player names
▼ Last_scores_points	Array[09] of SInt		True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[0]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[1]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[2]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[3]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[4]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[5]	SInt	0	True	True	True	True	False		Array of up to 5 last game scores
Last_scores_points[6]	SInt	0	True	True	True		False		Array of up to 5 last game scores
Last_scores_points[7]	SInt	0	True	True	True		False		Array of up to 5 last game scores
Last_scores_points[8]	SInt	0	True	True	True		False		Array of up to 5 last game scores
·	SInt	0	True	True	True		False		Array of up to 5 last game scores
Last_scores_points[9]		U							, ,
▼ High_scores_names	Array[09] of String	п	True	True	True		False		Array of up to 5 highest scores play names
High_scores_names[0]	String		True	True	True		False		Array of up to 5 highest scores play names
High_scores_names[1]	String	"	True	True	True	True	False		Array of up to 5 highest scores play names
High_scores_names[2]	String		True	True	True	True	False		Array of up to 5 highest scores play names
High_scores_names[3]	String	11	True	True	True	True	False		Array of up to 5 highest scores play names
High_scores_names[4]	String	11	True	True	True	True	False		Array of up to 5 highest scores play names
High_scores_names[5]	String	11	True	True	True	True	False		Array of up to 5 highest scores play names
High_scores_names[6]	String	11	True	True	True	True	False		Array of up to 5 highest scores play names
High_scores_names[7]	String	П	True	True	True	True	False		Array of up to 5 highest scores play names
High_scores_names[8]	String	11	True	True	True	True	False		Array of up to 5 highest scores play names
High_scores_names[9]	String	11	True	True	True	True	False		Array of up to 5 highest scores play
▼ High_scores_points	Array[09] of SInt		True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[0]	Sint	0	True	True	True	True	False		Array of up to 5 highest scores
· · · · · · · · · · · · · · · · · · ·		0		True	True		False		Array of up to 5 highest scores
High_scores_points[1]	SInt		True						
High_scores_points[2]	SInt	0	True	True	True		False		Array of up to 5 highest scores
High_scores_points[3]	SInt	0	True	True	True		False		Array of up to 5 highest scores
High_scores_points[4]	SInt	0	True	True	True		False		Array of up to 5 highest scores
High_scores_points[5]	SInt	0	True	True	True		False		Array of up to 5 highest scores
High_scores_points[6]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[7]	SInt	0	True	True	True		False		Array of up to 5 highest scores

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ne	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment
High_scores_points[8]	SInt	0	True	True	True	True	False		Array of up to 5 highest scores
High_scores_points[9]	SInt	0	True	True	True		False		Array of up to 5 highest scores
Scores_saved	Bool	false	False	True	True	True	False		Default false; Tells the program whether the Save_Score subroutine has been executed
Player_1_turn	Bool	true	False	True	True	True	False		Default true; tells the program which player's turn it is
Possible_moves	SInt	0	False	True	True	True	False		Default 0; number of possible move in current turn
Zero_move_change	Bool	false	False	True	True	True	False		Default false; tells the program whether last turn was invalid and crent player has been toggled
Reset	Bool	false	False	True	True	True	False		Default false; tells the PLC to reset to board and set default values
Game_over	Bool	false	False	True	True	True	False		Default false; tells the PLC if a game has finished
Game_started	Bool	false	False	True	True	True	False		Default false; tells the PLC that a game is in progress
Player_1_name	String	'Maciej'	False	True	True	True	False		Default "Maciej"; name of Player 1
Player_1_color	SInt	1	False	True	True		False		Default 1; color of Player 1
Player_1_points	SInt	0	False	True	True		False		Default 0; points of Player 1
Player_2_color Player_2_name	SInt String	'Szymon'	False False	True True	True True		False False		Default "Szymon"; name of Player 2 Default 1; color of Player 2
Player_2_name Player_2_points	SInt	0	False		True		False		Default 0; points of Player 2
✓ Square	Array[064] of SInt		False	True	True		False		Array of elements that define the crent state of the board
Square[0]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[1]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[2]	SInt	0	False	True	True		False		Array of elements that define the crent state of the board
Square[3]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[4]	SInt	0	False	True	True		False		Array of elements that define the crent state of the board
Square[5]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[6]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[7]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[8]	SInt	0	False	True	True	True	False		Array of elements that define the orent state of the board
Square[9]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[10]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[11]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[12]	SInt	0	False	True	True	True	False		Array of elements that define the
Square[13]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the crent state of the board
Square[14]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[15]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[16]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[17]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[18]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[19]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[20]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[21]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[22]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[23]	SInt	0	False	True	True	True	False		Array of elements that define the crent state of the board
Square[24]	SInt	0	False	True	True	True	False		Array of elements that define the
Square[2E]	SInt	0	Falso	True	Truo	-	Falso		rent state of the board

Square[25]

Square[26]

Square[27]

SInt

SInt

SInt

0

0

0

False

False

False

True

True

True

True True

True True

True True

False

False

False

Array of elements that define the current state of the board

Array of elements that define the current state of the board

Array of elements that define the current state of the board

Totally Integrated Automation Portal									
Name	Data type	Start value	Retain	HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment
Square[28]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[29]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[30]	SInt	0	False	True	True	True	False		Array of elements that define the cur-
Square[31]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[32]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[33]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[34]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[35]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[36]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[37]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[38]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[39]	SInt	0	False	True	True		False		rent state of the board Array of elements that define the cur-
Square[40]	SInt	0	False	True	True		False		rent state of the board Array of elements that define the cur-
	SInt	0		True	True		False		rent state of the board Array of elements that define the cur-
Square[41]			False						rent state of the board
Square[42]	SInt	0	False	True	True		False		Array of elements that define the cur- rent state of the board
Square[43]	SInt	0	False	True	True		False		Array of elements that define the current state of the board
Square[44]	SInt	0	False	True	True		False		Array of elements that define the cur- rent state of the board
Square[45]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[46]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[47]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[48]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[49]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[50]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[51]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[52]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[53]	SInt	0	False	True	True	True	False		Array of elements that define the current state of the board
Square[54]	SInt	0	False	True	True	True	False		Array of elements that define the cur-
Square[55]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[56]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[57]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[58]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[59]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[60]	SInt	0	False	True	True	True	False		rent state of the board Array of elements that define the cur-
Square[61]	SInt	0	False	True	True		False		rent state of the board Array of elements that define the cur-
Square[62]	SInt	0	False	True	True		False		rent state of the board Array of elements that define the cur-
Square[63]	SInt	0	False	True	True		False		rent state of the board Array of elements that define the cur-
Square[64]	SInt	20	False	True	True		False		rent state of the board An arbitrary index to set if no valid
							False		move is calculated. Color of currently playing player
Current_player_color Rival player color	SInt SInt	0	False False	True True	True True		False		Color of currently playing player Color of currently not playing player

True

True

True

True

True

True True

True True

True True

True True

True True

False

Color of currently not playing player

Default 0; index of currently clicked

Default false; check the board wheth-

er current move is valid and take over

Default 1; turns on hints in game

Default 1; for memorizing player 2

place on the board

color while in menu

places if it is

0

0

1

false

SInt

SInt

Bool

Bool

SInt

Rival_player_color

Player_2_color_memory

 $Current_block$

Check_all

Hints_on

utomation Portal									
ne	Data type	Start value	Retain	API	able from HMI/ OPC UA/ Web	HMI engi- neering	Setpoint	Supervi- sion	Comment
Player_1_color_memory	SInt	0	False		API True	True	False		Default 0; for memorizing player color while in menu
Check_if_green	Bool	false	False	True	True	True	False		color while in menu Default false; check the board fo green places (possible moves)

Program blocks

Vertical_Check [FB1]

al	Vertical_Check	Num	ber	1		Туре	FB			Lanc	juage	LAD
ne nbering	Automatic			<u> </u>		.,,,,	, 5				,	2.15
ormation												
le rsion	0.1	Auth	or -defined ID			Comment				Fam	ily	
rsion	0.1	oser-	-defined ib									
me		Data type	Default va	lue	Retain		HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment
Input								AFI				
Current_	hlock	SInt	0		Non-retain		True	True	True	False		
Rival col		SInt	0		Non-retain			True		False		
Current_		SInt	0		Non-retain		True	True	True	False		
Only_ch		Bool	false		Non-retain		True	True	True	False		
Output												
Finish		Bool	false		Non-retain		True	True	True	False		
InOut					32.11							
Static												
▼ Take_Ov	er_Up	"Take_Over"					True	True	True	True		
▼ Input		_===										
	al color	Cint	0		Non zata!		Truo	True	True	False		
	al_color rent_color	SInt SInt	0		Non-retain			True		False		
	rent_color uare1	SInt	0		Non-retain			True		False		
	Jare 1 Jare 2	SInt	0		Non-retain			True		False		1
	uare3	SInt	0		Non-retain			True		False		
	uare4	SInt	0		Non-retain			True	True	False		
	uare5	SInt	0		Non-retain		True	True	True	False		
·	uare6	SInt	0		Non-retain		True	True	True	False		
Sqı	uare7	SInt	0		Non-retain		True	True	True	False		
Mo	ve1	Bool	false		Non-retain		True	True	True	False		
Mo	ve2	Bool	false		Non-retain			True		False		
	ve3	Bool	false		Non-retain			True		False		
	ve4	Bool	false		Non-retain			True		False		
	ve5	Bool	false		Non-retain			True		False		
	ve6	Bool	false		Non-retain			True		False		
	ve7 rent_block	Bool SInt	false 0		Non-retain			True True		False False		
	ly_check	Bool	false		Non-retain			True		False		
▼ Outpu	-	Bool	laise		Non retuin		Truc	Truc	Truc	Tuise		
Do		Bool	false		Non-retain		True	True	True	False		
InOut		Воот	Taise		Non retain		True	Tiue	True	i disc		
Static												
▼ Take_Ov	er_Down	"Take_Over"					True	True	True	True		
▼ Input												
	al_color	SInt	0		Non-retain		True	True	True	False		
	rent_color	Sint	0		Non-retain			True		False		
	uare1	SInt	0		Non-retain			True		False		
	uare2	SInt	0		Non-retain			True		False		
	uare3	SInt	0		Non-retain			True		False		
	uare4	SInt	0		Non-retain			True		False		
	uare5	SInt	0		Non-retain			True		False		
	uare6	SInt	0		Non-retain		True	True	True	False		
Sqı	uare7	SInt	0		Non-retain			True		False		
	ve1	Bool	false		Non-retain			True		False		
	ve2	Bool	false		Non-retain			True		False		
	ve3	Bool	false		Non-retain			True		False		
	ve4	Bool	false		Non-retain			True		False		
	ve5	Bool	false		Non-retain			True		False		
	ve6	Bool Bool	false false		Non-retain			True True		False False		
	rent_block	SInt	0		Non-retain			True		False		
	rent_block ly_check	Bool	false		Non-retain			True		False		
▼ Outpu	-					•		., ac		. 3.30		1
Do		Bool	false		Non-retain		True	True	True	False		
InOut		Bool	iuise		INOTE TELATE	1	TIUC	iiue	TIUC	ו עוזכר		
Static												
Jialic												

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Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment
Square1	SInt								Up 7
Square2	SInt								Up 6
Square3	SInt								Up 5
Square4	SInt								Up 4
Square5	SInt								Up 3
Square6	SInt								Up 2
Square7	SInt								Up 1
Square8	SInt								Down 1
Square9	SInt								Down 2
Square10	SInt								Down 3
Square11	SInt								Down 4
Square12	SInt								Down 5
Square13	SInt								Down 6
Square14	SInt								Down 7
Up1	Bool								
Up2	Bool								
Up3	Bool								
Up4	Bool								
Up5	Bool								
Up6	Bool								
Up7	Bool								
Down1	Bool								
Down2	Bool								
Down3	Bool								
Down4	Bool								
Down5	Bool								
Down6	Bool								
Down7	Bool								
Constant									

Network 1:

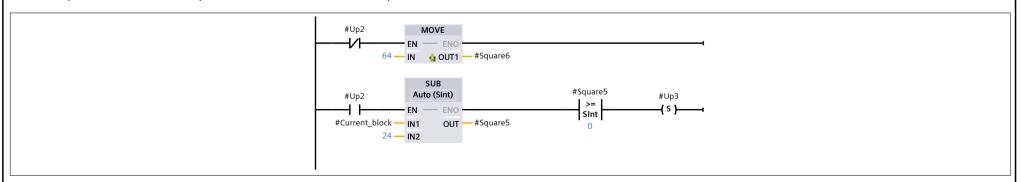
Calculate possible index in the up direction and set truth value Up1

Network 2:

Calculate possible index in the up direction and set truth value Up2

Network 3:

Calculate possible index in the up direction and set truth value Up3



Network 4:

Calculate possible index in the up direction and set truth value $\ensuremath{\mathsf{Up4}}$

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Network 5:

Calculate possible index in the up direction and set truth value Up5

Network 6:

Calculate possible index in the up direction and set truth value Up6

Network 7:

Calculate possible index in the up direction and set truth value Up7

Network 8:

Reset value if no move set

Network 9:

Calculate possible index in the down direction and set truth value Down1

```
ADD
Auto (SInt)

EN ENO
#Current_block | IN1 OUT | #Square8 #Down1

**Square8 #Down1

$ = Sint | (s) |
```

Network 10:

Calculate possible index in the down direction and set truth value Down2

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Network 11:

Calculate possible index in the down direction and set truth value Down3

Network 12:

Calculate possible index in the down direction and set truth value Down4

Network 13:

Calculate possible index in the down direction and set truth value Down5

Network 14:

Calculate possible index in the down direction and set truth value Down6

Network 15:

Calculate possible index in the down direction and set truth value Down7

Network 16:

Reset value if no move set

```
#Down7
EN ENO
IN OUT1
#Square14
```

Network 17:

Check squares for conditions of takeover and take over squares if #Only_check is set to 0.

Totally Integrated **Automation Portal** #Take_Over_Up %FB2 "Take_Over" - EN ENO -#Rival_color — Rival_color **Done →**false #Current_color — Current_color #Square7 — Square1 #Square6 — Square2 #Square5 — Square3 #Square4 — Square4 #Square3 — Square5 #Square2 — Square6 #Square1 — Square7 #Up1 — Move1 #Up2 — Move2 #Up3 — Move3 #Up4 — Move4 #Up5 — Move5 #Up6 — **Move6** #Up7 — Move7 #Current_block — Current_block #Only_check — Only_check #Take_Over_ Down %FB2 #Take_Over_ Up.Done "Take_Over" ENO -#Rival_color — Rival_color Done →#Finish #Current_color — Current_color #Square8 — Square1 #Square9 — Square2 #Square10 — Square3 #Square11 — Square4 #Square12 — Square5 #Square13 — Square6 #Square14 — Square7 #Down1 — Move1 #Down2 — Move2 #Down3 — Move3 #Down4 — Move4 #Down5 — Move5 #Down6 — Move6 #Down7 — Move7 #Current_block — Current_block #Only_check — Only_check

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Automation Portal	

Program blocks

Horizontal_Check [FB3]

orizontal_Check Properties eneral												
					-							
me	Horizontal_Check	N	umber 3		Туре	FB			Lang	luage	LAD	
mbering formation	Automatic											
le		Δ.	uthor		Comment				Fami	ilv		
ersion	0.1		ser-defined ID		Comment				Ганн	шу		
2131011	0.1	U.	ser-defined iD									
ame		Data type	Default value	Retain		Accessible from HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment	
Input							AFI					
<u> </u>						_	_	_				
Current_		SInt	0	Non-retair		True	True		False			
Rival_col		SInt	0	Non-retair		True	True		False			
Current_		SInt	0	Non-retaii		True	True		False			
Only_che	eck	Bool	false	Non-retaii	1	True	True	True	False			
Output												
Finish		Bool	false	Non-retair	า	True	True	True	False			
InOut					_							
▼ Static												
▼ Take_Ove	er Left	"Take_Over"	ı			True	True	True	True			
▼ Input												
	al_color	SInt	0	Non-retair		True	True		False			
	rent_color	SInt	0	Non-retaii		True	True		False			
	uare1	SInt	0	Non-retaii		True	True		False			
Squ	uare2	SInt	0	Non-retaii	า	True	True		False			
Squ	uare3	SInt	0	Non-retaiı	า	True	True		False			
Squ	uare4	SInt	0	Non-retaiı	า	True	True	True	False			
Squ	uare5	SInt	0	Non-retai	า	True	True	True	False			
Squ	uare6	SInt	0	Non-retaii	า	True	True	True	False			
Squ	uare7	SInt	0	Non-retaiı	า	True	True	True	False			
Мо	ve1	Bool	false	Non-retaii	า	True	True	True	False			
Мо	ve2	Bool	false	Non-retaiı	ı	True	True	True	False			
Мо	ve3	Bool	false	Non-retaiı	า	True	True	True	False			
Мо	ve4	Bool	false	Non-retaiı	า	True	True	True	False			
Мо	ve5	Bool	false	Non-retaiı	า	True	True	True	False			
Мо	ve6	Bool	false	Non-retaiı	า	True	True	True	False			
Мо	ve7	Bool	false	Non-retaiı	ı	True	True	True	False			
Cur	rent_block	SInt	0	Non-retaiı	า	True	True	True	False			
On	ly_check	Bool	false	Non-retair	า	True	True	True	False			
▼ Outpu	it											
Doi	ne	Bool	false	Non-retai	า	True	True	True	False			
InOut							111111					
Static												
▼ Take_Ove	er_Right	"Take_Over"				True	True	True	True			
·	al color	SInt	0	Non-retaiı	•	True	True	Truo	False			
	al_color	Sint	0	Non-retaii		True	True		False			
	rent_color uare1	SInt	0	Non-retair		True	True		False			
		Sint	0	Non-retair		True	True		False			
	Jare2	Sint	0	Non-retaii Non-retaii			True		False			
	Jare3	Sint	0	Non-retair		True True	True		False			
	uare4 uare5	SInt	0	Non-retair		True	True		False			
		Sint	0	Non-retaii		True	True		False			
	Jare6	Sint	0	Non-retair		True	True		False			
	uare7	Bool	false	Non-retaii Non-retaii			True		False			
Mo	ve2	Bool	false	Non-retaii		True True	True		False			
	ve3	Bool	false	Non-retair		True	True		False			
Mo Mo		Bool	false	Non-retair		True	True		False			
			false	Non-retaii Non-retaii					False			
	ve5	Bool		Non-retaii Non-retaii		True	True True					
	ve6	Bool	false			True			False			
	ve7	Bool	false	Non-retair		True	True		False			
	rent_block	SInt	0 false	Non-retair		True	True		False			
On ▼ Outpu	ly_check it	Bool	false	Non-retai		True	True		False			
Doi		Bool	false	Non-retaiı	1	True	True	True	False			
InOut												
Static												
▼ Temp												

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Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment
Square1	SInt								Left 7
Square2	SInt								Left 6
Square3	SInt								Left 5
Square4	SInt								Left 4
Square5	SInt								Left 3
Square6	SInt								Left 2
Square7	SInt								Left 1
Square8	SInt								Right 1
Square9	SInt								Right 2
Square10	SInt								Right 3
Square11	SInt								Right 4
Square12	SInt								Right 5
Square13	SInt								Right 6
Square14	SInt								Right 7
Left	SInt								
Left1	Bool								
Left2	Bool								
Left3	Bool								
Left4	Bool								
Left5	Bool								
Left6	Bool								
Left7	Bool								
Right	SInt								
Right1	Bool								
Right2	Bool								
Right3	Bool								
Right4	Bool								
Right5	Bool								
Right6	Bool								
Right7	Bool								
Constant									

Network 1:

Calculate possible index in the left direction and set truth values Left1

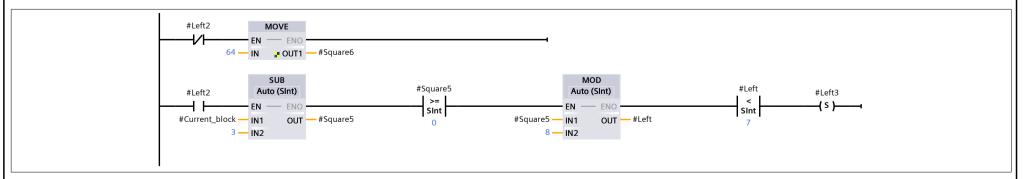
Network 2:

Calculate possible index in the left direction and set truth values Left2

```
#Left1
              MOVE
              EN - ENO
         64 — IN 🔄 OUT1 — #Square7
               SUB
                                                                                MOD
                                                #Square6
                                                                                                                #Left
               Auto (SInt)
                                                                              Auto (SInt)
 #Left1
                                                                                                                               #Left2
                                                 >=
SInt
                                                                                                                <
SInt
  \dashv \vdash
                                                                                                                                -( s )-
              EN - ENO
                                                                             EN - ENO
                   OUT — #Square6
#Current_block -
                                                                   #Square6 — IN1
                                                                                  OUT — #Left
             IN1
              IN2
                                                                         8 — IN2
```

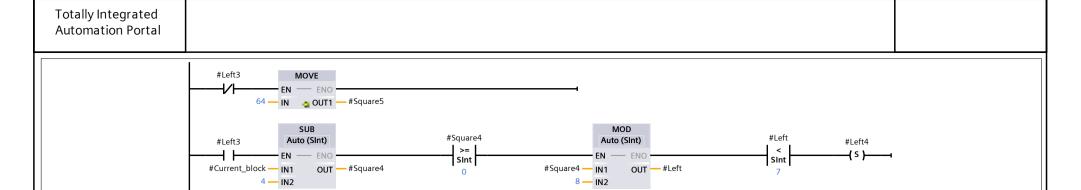
Network 3:

Calculate possible index in the left direction and set truth values Left3



Network 4:

Calculate possible index in the left direction and set truth values Left4



Network 5:

Calculate possible index in the left direction and set truth values Left5

```
#Left4
            MOVE
            EN - ENO
        64 — IN ■ OUT1 — #Square4
            SUB
                                                                       MOD
                                                                                                    #Left
                                          #Square3
                                                                                                                  -( s )-
            EN - ENO
                                                                     EN - ENO -
                                           SInt
                                                                                                    SInt
#Current_block — IN1 OUT — #Square3
                                                           #Square3 — IN1
                                                                         OUT — #Left
         5 — IN2
                                                                 8 — IN2
```

Network 6:

Calculate possible index in the left direction and set truth values Left6

```
MOVE
             EN - ENO
        64 — IN __ OUT1 — #Square3
             SUB
                                                                           MOD
                                             #Square2
                                                                                                          #Left
             Auto (SInt)
                                                                          Auto (SInt)
 #Left5
                                                                                                                        #Left6
                                              >=
SInt
             EN - ENO
                                                                              - ENO -
                                                                         EN -
                                                                                                         SInt
                                                               #Square2 — IN1
                                                                               OUT — #Left
#Current_block — IN1 OUT — #Square2
```

Network 7:

Calculate possible index in the left direction and set truth values Left7

```
#Left6
             MOVE
             EN - ENO
        64 — IN - OUT1 — #Square2
               SUB
                                                                             MOD
                                                                                                           #Left
                                             #Square1
#Left6
              Auto (SInt)
                                                                           Auto (SInt)
                                                                                                                          #Left7
                                              >=
SInt
             EN --- ENO
                                                                                                                          -( s )-
                                                                                                           SInt
                                                                #Square1 — IN1
                                                                              OUT — #Left
#Current_block — IN1 OUT — #Square1
         7 — IN2
                                                                     8 — IN2
```

Network 8:

Reset value if move not set

```
#Left7
EN ENO
IN OUT1 #Square1
```

Network 9:

Calculate possible index in the right direction and set truth value Right1

Network 10:

Calculate possible index in the right direction and set truth value Right2

```
#Right1
             MOVE
             EN - ENO
        64 — IN 🛕 OUT1 — #Square8
             ADD
                                                            MOD
                                                                                           #Right
             Auto (SInt)
                                                           Auto (SInt)
#Right1
                                                                                                         #Right2
                                                                                          | >
| SInt
 \dashv \vdash
             EN - ENO
                                                          EN - ENO
                                                                                                          -( s )−
#Current_block — IN1 OUT — #Square9
                                               #Square9 — IN1 OUT — #Right
         2 — IN2 🔒
                                                      8 — IN2
```

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Network 11:

Calculate possible index in the right direction and set truth value Right3

```
#Right2
             - EN --- ENO -
         64 — IN 👍 OUT1 — #Square9
              ADD
                                                                 MOD
                                                                                                 #Right
              Auto (SInt)
                                                               Auto (SInt)
#Right2
                                                                                                                 #Right3
 \dashv \vdash
              - EN --- ENO -
                                                                                                                  -( s )-
                                                                                                  SInt
#Current_block — IN1 OUT — #Square10
                                                   #Square10 — IN1
                                                                    OUT — #Right
          3 — IN2 🛕
                                                          8 — IN2
```

Network 12:

Calculate possible index in the right direction and set truth value Right4

```
#Right3 MOVE
EN ENO
64 IN OUT1 #Square10

#Right3 ADD
Auto (Sint)

#Right3 EN ENO
#Current_block IN1 OUT #Square11 #Square11 IN1 OUT #Right

4 IN2 IN Square11 #Square11 | N1 OUT #Right

8 IN2
```

Network 13:

Calculate possible index in the right direction and set truth value Right5

```
#Right4
          MOVE
          EN - ENO
      64 — IN 📥 OUT1 — #Square11
          ADD
                                            MOD
                                                                     #Right
          Auto (SInt)
                                             Auto (SInt)
                                                                                #Right5
- EN --- ENO -
                                                                                 -( s )-
                                                                     SInt
                                    #Square12 — IN1 OUT — #Right
       5 — IN2 👍
```

Network 14:

Calculate possible index in the right direction and set truth value Right6

```
#Right5
             MOVE
             EN - ENO
         64 — IN <u>a</u> OUT1 — #Square12
               ADD
                                                                                             #Right
             Auto (SInt)
                                                            Auto (SInt)
#Right5
                                                                                                            #Right6
 \dashv \vdash
              EN - ENO
                                                            EN - ENO
                                                                                                             -( s )-
#Current_block — IN1 OUT — #Square13
                                                #Square13 — IN1 OUT — #Right
         6 — IN2 🛕
                                                        8 — IN2
```

Network 15:

 ${\it Calculate\ possible\ index\ in\ the\ right\ direction\ and\ set\ truth\ value\ Right7}$

Network 16:

Reset variable if move not set

Network 17:

Check squares for conditions of takeover and take over squares if #Only_check is set to 0.

Totally Integrated **Automation Portal** #Take_Over_Left %FB2 "Take_Over" - EN ENO -#Rival_color — Rival_color **Done →**false #Current_color — Current_color #Square7 — Square1 #Square6 — Square2 #Square5 — Square3 #Square4 — Square4 #Square3 — Square5 #Square2 — Square6 #Square1 — Square7 #Left1 — Move1 #Left2 — Move2 #Left3 — Move3 #Left4 — Move4 #Left5 — Move5 #Left6 — Move6 #Left7 — Move7 #Current_block — Current_block #Only_check — Only_check #Take_Over_Right #Take_Over_ Left.Done %FB2 "Take_Over" - EN ENO -**Done →**#Finish #Rival_color — Rival_color #Current_color — Current_color #Square8 — Square1 #Square9 — Square2 #Square10 — Square3 #Square11 — Square4 #Square12 — Square5 #Square13 — Square6 #Square14 — Square7 #Right1 — Move1 #Right2 — Move2 #Right3 — Move3 #Right4 — Move4 #Right5 — Move5 #Right6 — Move6 #Right7 — Move7 #Current_block — Current_block #Only_check — Only_check

Integrated	
Automation Portal	

Program blocks

NW-SE_Check [FB4]

ral										
ne	NW-SE_Check	Nun	nber 4	Туре	FB			Lang	Juage	LAD
mbering	Automatic									
ormation le		041		Camanant				F= :	:I	
rsion	0.1	Auth	r-defined ID	Comment				Fam	пу	
:131011	0.1	Osei	-defined iD							
me		Data type	Default value	Retain	Accessible					Comment
					from		HMI engi-		sion	
					HMI/OPC UA/Web	trom HMI/	neering			
					API	OPC				
						UA/				
						Web				
						API				
Input										
Current_	_block	SInt	0	Non-retain	True	True	True	False		
Rival_co		SInt	0	Non-retain	True	True	True	False		
Current_	_color	SInt	0	Non-retain	True	True	True	False		
Only_ch	eck	Bool	false	Non-retain	True	True	True	False		
Output										
Finish		Bool	false	Non-retain	True	True	True	False		
InOut										
Static										
▼ Take_Ov	ver Upleft	"Take_Over"			True	True	True	True		
		Take_Over								
▼ Input										
Riv	/al_color	SInt	0	Non-retain	True	True		False		
Cu	rrent_color	SInt	0	Non-retain	True	True	True	False		
Sq	uare1	SInt	0	Non-retain	True	True		False		
Sq	uare2	SInt	0	Non-retain	True	True	True	False		
Sq	uare3	SInt	0	Non-retain	True	True	True	False		
Sq	uare4	SInt	0	Non-retain	True	True	True	False		
Sq	uare5	SInt	0	Non-retain	True	True	True	False		
Sq	uare6	SInt	0	Non-retain	True	True	True	False		
Sq	uare7	SInt	0	Non-retain	True	True	True	False		
Мо	ove1	Bool	false	Non-retain	True	True	True	False		
Мо	ove2	Bool	false	Non-retain	True	True	True	False		
Мо	ove3	Bool	false	Non-retain	True	True	True	False		
Mo	ove4	Bool	false	Non-retain	True	True	True	False		
	ove5	Bool	false	Non-retain	True	True	True	False		
Mo	ove6	Bool	false	Non-retain	True	True	True	False		
	ove7	Bool	false	Non-retain	True	True		False		
Cu	ırrent_block	SInt	0	Non-retain	True	True	True	False		
	nly_check	Bool	false	Non-retain	True	True	True	False		
▼ Outp	-									
	one	Bool	false	Non-retain	True	True	True	False		
InOut		Воог	laise	Non-retain	True	True	True	i dise		
Static										
	/er_DownRight	"Take_Over"			True	True	Truo	Truo		
		Take_Over			True	True	True	True		
▼ Input										
Riv	/al_color	SInt	0	Non-retain	True	True	True	False		
Cu	rrent_color	SInt	0	Non-retain	True	True	True	False		
	uare1	SInt	0	Non-retain	True	True	True	False		
	uare2	SInt	0	Non-retain	True	True	True	False		
	uare3	SInt	0	Non-retain	True	True		False		
	uare4	SInt	0	Non-retain	True	True		False		
	uare5	SInt	0	Non-retain	True	True		False		
	uare6	SInt	0	Non-retain	True	True		False		
	uare7	SInt	0	Non-retain	True	True		False		
	ove1	Bool	false	Non-retain	True	True		False		
	ove2	Bool	false	Non-retain	True	True		False		
	ove3	Bool	false	Non-retain	True	True		False		
	ove4	Bool	false	Non-retain	True	True		False		
	ove5	Bool	false	Non-retain	True	True		False		
	ove6	Bool	false	Non-retain	True	True		False		
	ove7	Bool	false	Non-retain	True	True		False		
	rrent_block	SInt	0	Non-retain	True	True		False		
	nly_check	Bool	false	Non-retain	True	True		False		
▼ Outp	•									
		D.cI	falas	Non- and the	T	T	T	F-1		
	ne	Bool	false	Non-retain	True	True	ırue	False		
InOut										
Statio	:									
Temp		1			1			1		

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	HMI engi- neering	Setpoint	Supervi- sion	Comment
Square1	SInt				/ 11 1				UpLeft 7
Square2	SInt								UpLeft 6
Square3	SInt								UpLeft 5
Square4	SInt								UpLeft 4
Square5	SInt								UpLeft 3
Square6	SInt								UpLeft 2
Square7	SInt								UpLeft 1
Square8	SInt								DownRight 1
Square9	SInt								DownRight 2
Square10	SInt								DownRight 3
Square11	SInt								DownRight 4
Square12	SInt								DownRight 5
Square13	SInt								DownRight 6
Square14	SInt								DownRight 7
UpLeft	SInt								Downing it i
UpLeft1	Bool								
UpLeft2	Bool								
UpLeft3	Bool								
UpLeft4	Bool								
UpLeft5	Bool								
UpLeft6	Bool								
UpLeft7	Bool								
DownRight	SInt								
DownRight1	Bool								
DownRight2	Bool								
DownRight3	Bool								
DownRight4	Bool								
DownRight4 DownRight5	Bool								
	Bool								
DownRight6									
DownRight7	Bool								
Constant									

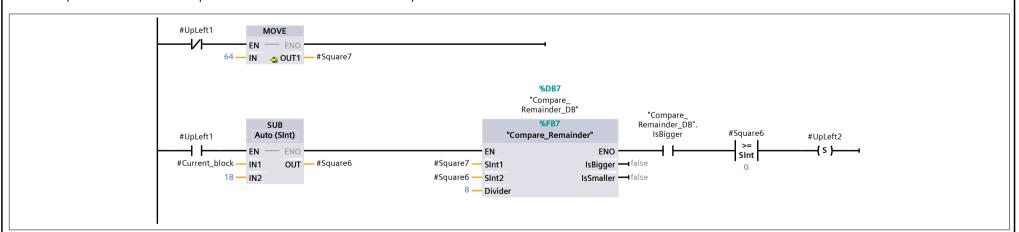
Network 1:

Calculate possible index in the Up-left direction and set truth value UpLeft1

```
%DB7
                                                                                     "Compare_
Remainder_DB"
                                                                                                                  "Compare_
Remainder_DB".
IsBigger
                                                                                        %FB7
                    SUB
                                                                                                                                         #Square7
                   Auto (SInt)
                                                                                                                                                            #UpLeft1
                                                                                                                                          >=
SInt
                                                                                                                                                              -( s )-
                                                                            EN
                                                                                                        ENO
                                                                                                     IsBigger → false
#Current_block —
                IN1
                         OUT — #Square7
                                                          #Current_block — SInt1
            9 — IN2
                                                               #Square7 — SInt2
                                                                                                    IsSmaller — false
                                                                       8 — Divider
```

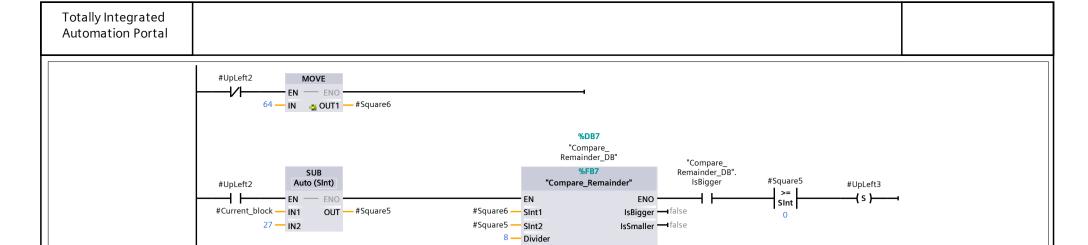
Network 2:

Calculate possible index in the Up-left direction and set truth value UpLeft2



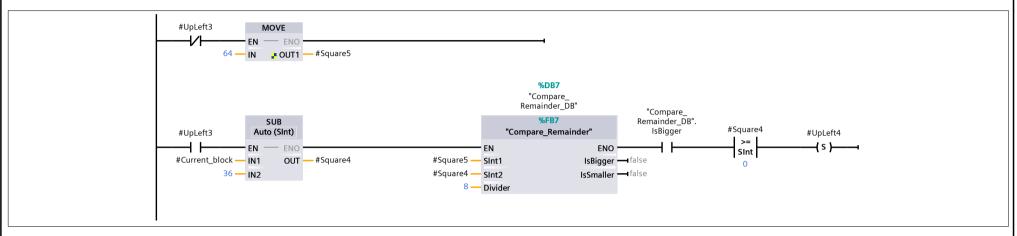
Network 3:

Calculate possible index in the Up-left direction and set truth value UpLeft3



Network 4:

Calculate possible index in the Up-left direction and set truth value UpLeft4



Network 5:

Calculate possible index in the Up-left direction and set truth value UpLeft5

```
#UpLeft4
                EN - ENO
          64 — IN 🚤 OUT1 — #Square4
                                                                                     %DB7
                                                                                 "Compare_
Remainder_DB"
                                                                                                             "Compare_
Remainder_DB".
                                                                                     %FB7
                    SUB
                                                                                                                                  #Square3
                                                                                                                ls Bigger
                                                                                                                                                     #UpLeft5
#UpLeft4
#Current_block -
                        OUT — #Square3
                                                            #Square4 — SInt1
                                                                                                IsBigger → false
                IN1
          45 — IN2
                                                            #Square3 — SInt2
                                                                                                IsSmaller → false
                                                                    8 — Divider
```

Network 6:

Calculate possible index in the Up-left direction and set truth value UpLeft6

```
#UpLeft5
               MOVE
               EN - ENO
          64 — IN _ OUT1 — #Square3
                                                                                %DB7
                                                                              "Compare
                                                                            Remainder_DB"
                                                                                                      "Compare_
Remainder_DB".
                                                                                %FB7
                   SUB
                                                                                                                          #Square2
                                                                                                         ls Bigger
#UpLeft5
                                                                                                                                            #UpLeft6
                                                                                             ENO
                                                                                                                                             -( s }-
                                                                    · EN
#Current_block — IN1
                       OUT — #Square2
                                                         #Square3 — SInt1
                                                                                          IsBigger → false
          54 — IN2
                                                        #Square2 — SInt2
                                                                                          IsSmaller → false
                                                               8 — Divider
```

Network 7:

Calculate possible index in the Up-left direction and set truth value UpLeft7

```
#UpLeft6
                EN - ENO
          64 — IN 📲 OUT1 — #Square2
                                                                                    %DB7
                                                                               "Compare_
Remainder_DB"
                                                                                                          "Compare_
Remainder_DB".
                    SUB
                                                                                   %FB7
                                                                                                                                #Square1
                                                                            "Compare_Remainder"
                                                                                                              lsBigger
#UpLeft6
                                                                                                                                                  #UpLeft7
                                                                                                                                 SInt
#Current_block -
                                                                                              IsBigger → false
                IN1
                        OUT — #Square1
                                                           #Square2 — SInt1
          63 — IN2
                                                           #Square1 — SInt2
                                                                                              IsSmaller ─Ifalse
                                                                  8 — Divider
```

Network 8:

Reset value if no move set

Totally Integrated Automation Portal

```
#UpLeft7 MOVE
EN EN ENO
IN OUT1 #Square1
```

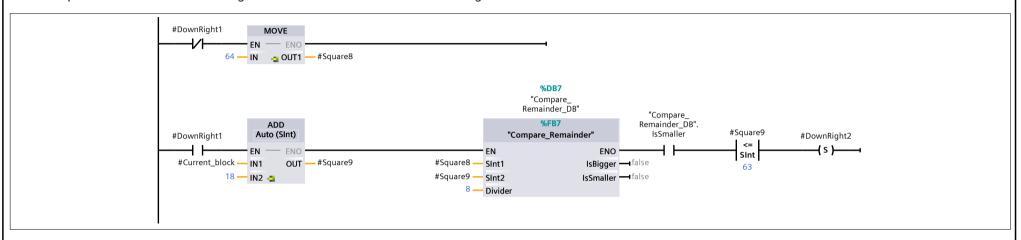
Network 9:

Calculate possible index in the Down-right direction and set truth value DownRight1

```
%DB7
                                                                                  "Compare_
Remainder_DB"
                                                                                                              "Compare_
Remainder_DB".
                                                                                      %FB7
                                                                                                                                    #Square8
                  Auto (SInt)
                                                                               "Compare_Remainder"
                                                                                                                IsSmaller
                                                                                                                                                    #DownRight1
                                                                                                                                                        -( s )-
                                                                         EN.
                                                                                                    ENO -
                                                                                                                                     SInt
                                                       #Current_block — SInt1
#Current_block — IN1 OUT — #Square8
                                                                                                 IsBigger → false
                                                             #Square8 — SInt2
            9 — IN2 🛂
                                                                                                IsSmaller ─Ifalse
                                                                    8 — Divider
```

Network 10:

Calculate possible index in the Down-right direction and set truth value DownRight2



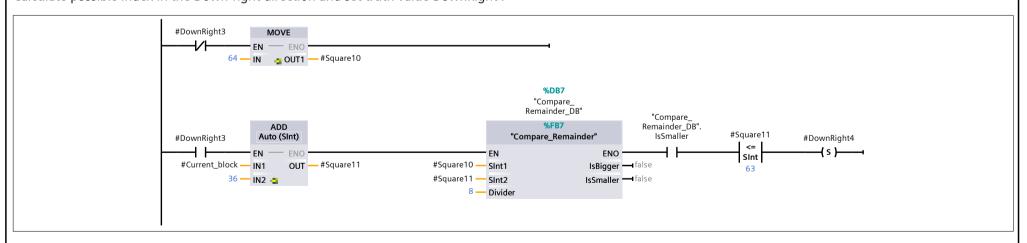
Network 11:

Calculate possible index in the Down-right direction and set truth value DownRight3

```
#DownRight2
               MOVE
                EN - ENO
          64 — IN POUT1 — #Square9
                                                                          "Compare_
Remainder_DB"
                                                                                                   "Compare_
Remainder_DB".
                                                                            %FB7
                  ADD
                                                                                                                      #Square10
#DownRight2
                 Auto (SInt)
                                                                       "Compare_Remainder"
                                                                                                      IsSmaller
                                                                                                                                      #DownRight3
                                                                                                                                         -( s )-
                EN - ENO
                                                                  - EN
                                                                                           ENO
                                                                                                                        SInt
#Current_block — IN1
                     OUT — #Square10
                                                       #Square9 — SInt1
                                                                                        IsBigger → false
          27 — IN2 👪
                                                      #Square10 — SInt2
                                                                                       IsSmaller → false
                                                              8 — Divide
```

Network 12:

Calculate possible index in the Down-right direction and set truth value DownRight4



Network 13:

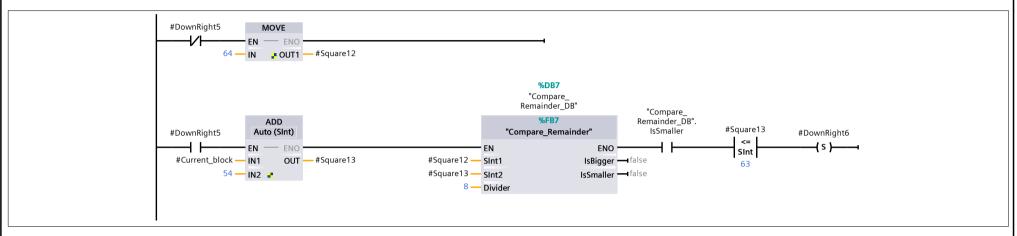
Calculate possible index in the Down-right direction and set truth value DownRight5

Totally Integrated
Automation Portal

```
#DownRight4
                MOVE
                EN - ENO
           64 — IN 📲 OUT1 — #Square11
                                                                                %DB7
                                                                            "Compare_
Remainder_DB"
                                                                                                      "Compare_
Remainder_DB".
                                                                                %FB7
                    ADD
                                                                         "Compare_Remainder"
                                                                                                        IsSmaller
                                                                                                                         #Square12
#DownRight4
                                                                                                                                         #DownRight5
                                                                                                                           SInt
                                                                                          IsBigger — false
 #Current_block —
                IN1 OUT — #Square12
                                                        #Square11 — SInt1
                                                        #Square12 — SInt2
           45 — IN2 🛥
                                                                                          IsSmaller ─Ifalse
                                                                8 — Divider
```

Network 14:

Calculate possible index in the Down-right direction and set truth value DownRight6



Network 15:

Calculate possible index in the Down-right direction and set truth value DownRight7

```
#DownRight6
                 EN - ENO
            64 — IN 🚤 OUT1 — #Square13
                                                                                     %DB7
                                                                                 "Compare_
Remainder_DB"
                                                                                                            "Compare_
Remainder_DB".
IsSmaller
                                                                                     %FB7
                     ADD
                                                                                                                                 #Square14
                                                                                                                                                  #DownRight7
#DownRight6
                                                                                                                                  SInt
                                                                                                IsBigger ─ false
 #Current_block —
                 - IN1 OUT — #Square14
                                                            #Square13 — SInt1
                                                           #Square14 — SInt2
            63 — IN2 📲
                                                                                               IsSmaller ─Ifalse
                                                                    8 — Divider
```

Network 16:

Reset value if no move set

Network 17:

Check squares for conditions of takeover and take over squares if #Only_check is set to 0.

Totally Integrated **Automation Portal** #Take_Over_ UpLeft %FB2 "Take_Over" ENO -· EN #Rival_color — Rival_color Done ─Ifalse #Current_color — Current_color #Square7 — Square1 #Square6 — Square2 #Square5 — Square3 #Square4 — Square4 #Square3 — Square5 #Square2 — Square6 #Square1 — Square7 #UpLeft1 — Move1 #UpLeft2 — Move2 #UpLeft3 — Move3 #UpLeft4 — Move4 #UpLeft5 — Move5 #UpLeft6 — Move6 #UpLeft7 — Move7 #Current_block — Current_block #Only_check — Only_check #Take_Over_ DownRight %FB2 #Take_Over_ UpLeft.Done "Take_Over" - EN ENO -Done →#Finish #Rival_color — Rival_color #Current_color — Current_color #Square8 — Square1 #Square9 — Square2 #Square10 — Square3 #Square11 — Square4 #Square12 — Square5 #Square13 — Square6 #Square14 — Square7 #DownRight1 — Move1 #DownRight2 — Move2 #DownRight3 — Move3 #DownRight4 — Move4 #DownRight5 — Move5 #DownRight6 — Move6 #DownRight7 — Move7 #Current_block — Current_block #Only_check — Only_check

Totally Integrated	
Automation Portal	

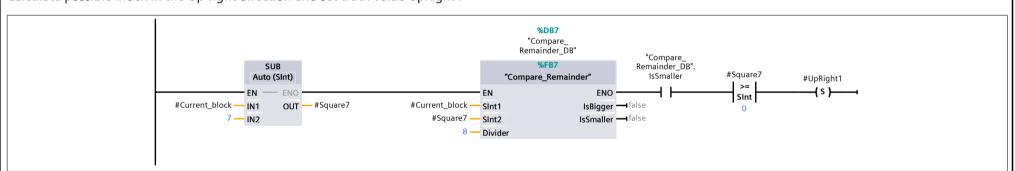
NE-SW_Check [FB5]

eral e	NE-SW_Check	Nun	iber 5	Туре	FB			lanc	juage	LAD
mbering	Automatic	Itali	3	Турс	ļi b			Larry	juage	Litto
ormation										
le		Auth	nor	Comment				Fam	ily	
rsion	0.1	Useı	-defined ID							
		D. t. t	D - f f	D - 4 - 3	A 11-1 -	\A/	\ /: - ! - - !	C - t ! t	C	C
me		Data type	Default value	Retain	Accessible from		HMI engi-	Setpoint	Supervi- sion	Comment
					HMI/OPC		neering		31011	
					UA/Web	HMI/				
					API	OPC				
						UA/				
						Web				
1						API				
Input										
Current_	block	SInt	0	Non-retain	True	True	True	False		
Rival_col	or	SInt	0	Non-retain	True	True	True	False		
Current_	color	SInt	0	Non-retain	True	True	True	False		
Only_che	eck	Bool	false	Non-retain	True	True	True	False		
Output										
<u> </u>		Bool	false	Non-retain	True	True	Truo	False		
Finish		P001	laise	NOIFIELAIII	iiue	rrue	iiue	i aise		
InOut										
Static										
▼ Take_Ov	er_UpRight	"Take_Over"			True	True	True	True		
▼ Input										
<u> </u>	1 -1	CL++		Niero e e e	T	T .	т	F-1-		
	al_color	SInt	0	Non-retain	True	True		False		
	rrent_color	SInt	0	Non-retain	True	True		False		
	uare1	SInt	0	Non-retain	True	True		False		
	uare2	SInt	0	Non-retain	True	True		False		
Squ	uare3	SInt	0	Non-retain	True	True	True	False		
Sqı	uare4	SInt	0	Non-retain	True	True	True	False		
Squ	uare5	SInt	0	Non-retain	True	True	True	False		
	uare6	SInt	0	Non-retain	True	True		False		
	uare7	SInt	0	Non-retain	True	True		False		
	ve1	Bool	false	Non-retain	True	True		False		
	ove2	Bool	false	Non-retain	True	True		False		
	ove3	Bool	false	Non-retain	True	True		False		
	ve4	Bool	false	Non-retain	True	True		False		
	ve5	Bool	false	Non-retain	True	True		False		
Мо	ve6	Bool	false	Non-retain	True	True		False		
Мо	ve7	Bool	false	Non-retain	True	True	True	False		
Cui	rrent_block	SInt	0	Non-retain	True	True	True	False		
On	ly_check	Bool	false	Non-retain	True	True	True	False		
▼ Outpu	-									
		Bool	false	Non-retain	True	True	Truo	False		
Do		БООІ	laise	Non-retain	True	True	True	raise		
InOut										
Static										
▼ Take_Ov	er_DownLeft	"Take_Over"			True	True	True	True		
▼ Input										
	al_color	SInt	0	Non-retain	True	True	True	False		
			0	Non-retain						
	rrent_color	SInt			True	True		False		
	uare1	SInt	0	Non-retain	True	True		False		
	uare2	SInt	0	Non-retain	True	True		False		
	uare3	SInt	0	Non-retain	True	True		False		
Squ	uare4	SInt	0	Non-retain	True	True		False		
Squ	uare5	SInt	0	Non-retain	True	True		False		
	uare6	SInt	0	Non-retain	True	True	True	False		
	uare7	SInt	0	Non-retain	True	True		False		
	ve1	Bool	false	Non-retain	True	True		False		
	ve2	Bool	false	Non-retain	True	True		False		
	ove3	Bool	false	Non-retain	True	True		False		
	ove4	Bool	false	Non-retain	True	True		False		
			false	Non-retain	True	True		False		
	ove5	Bool								
	ove6	Bool	false	Non-retain	True	True		False		
	ove7	Bool	false	Non-retain		True		False		
	rrent_block	SInt	0	Non-retain	True	True		False		
On	ly_check	Bool	false	Non-retain	True	True	True	False		
▼ Outpu	ıt									
Do	ne	Bool	false	Non-retain	True	True	True	False		
InOut		3001		TOTA TOTALITA				. 4130		
					1					
Static					1					
Temp										

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment
Square1	SInt								UpRight 7
Square2	SInt								UpRight 6
Square3	SInt								UpRight 5
Square4	SInt								UpRight 4
Square5	SInt								UpRight 3
Square6	SInt								UpRight 2
Square7	SInt								UpRight 1
Square8	SInt								DownLeft 1
Square9	SInt								DownLeft 2
Square10	SInt								DownLeft 3
Square11	SInt								DownLeft 4
Square12	SInt								DownLeft 5
Square13	SInt								DownLeft 6
Square14	SInt								DownLeft 7
UpRight1	Bool								
UpRight2	Bool								
UpRight3	Bool								
UpRight4	Bool								
UpRight5	Bool								
UpRight6	Bool								
UpRight7	Bool								
DownLeft1	Bool								
DownLeft2	Bool								
DownLeft3	Bool								
DownLeft4	Bool								
DownLeft5	Bool								
DownLeft6	Bool								
DownLeft7	Bool								
Constant									

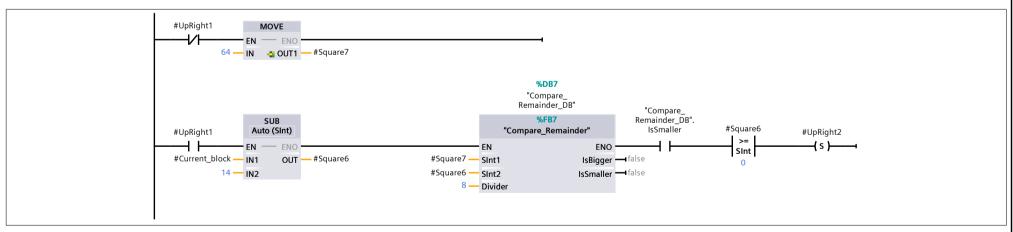
Network 1:

Calculate possible index in the Up-right direction and set truth value UpRight1



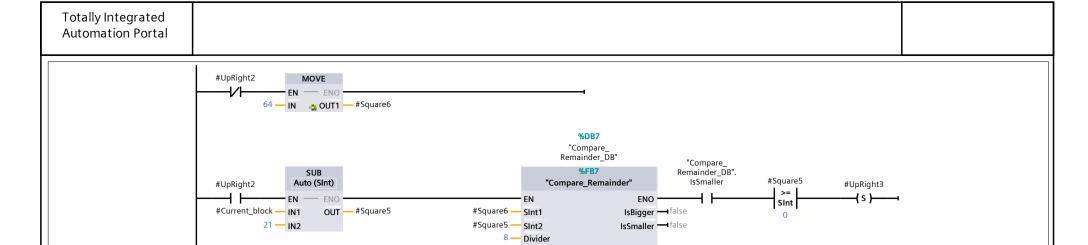
Network 2:

Calculate possible index in the Up-right direction and set truth value UpRight2



Network 3:

Calculate possible index in the Up-right direction and set truth value UpRight3



Network 4:

Calculate possible index in the Up-right direction and set truth value UpRight4

```
#UpRight3
                EN - ENO
          64 — IN POUT1 — #Square5
                                                                                     %DB7
                                                                                "Compare_
Remainder_DB"
                                                                                                            "Compare_
Remainder_DB".
                                                                                    %FB7
                    SUB
                                                                                                                                 #Square4
#UpRight3
                                                                                                               IsSmaller
                                                                                                                                                   #UpRight4
                                                                        EN
                                                                                                  ENO
                                                                                                                                                     -( s )-
                                                                                               IsBigger — false
#Current_block — IN1
                        OUT — #Square4
                                                            #Square5 — SInt1
          28 — IN2
                                                            #Square4 — SInt2
                                                                                              IsSmaller —Ifalse
                                                                   8 — Divider
```

Network 5:

Calculate possible index in the Up-right direction and set truth value UpRight5

```
#UpRight4
                EN - ENO
          64 — IN 🚤 OUT1 — #Square4
                                                                                     %DB7
                                                                                 "Compare_
Remainder_DB"
                                                                                                            "Compare_
Remainder_DB".
                                                                                     %FB7
                    SUB
                                                                                                                                  #Square3
                                                                                                               IsSmaller
                                                                                                                                                    #UpRight5
#UpRight4
                                                                                                                                   SInt
#Current_block -
                        OUT — #Square3
                                                            #Square4 — SInt1
                                                                                                IsBigger → false
                IN1
                                                            #Square3 — SInt2
                                                                                               IsSmaller → false
           35 — IN2
                                                                   8 — Divider
```

Network 6:

Calculate possible index in the Up-right direction and set truth value UpRight6

```
#UpRight5
               MOVE
               EN - ENO
          64 — IN _ OUT1 — #Square3
                                                                                %DB7
                                                                              "Compare
                                                                            Remainder_DB'
                                                                                                      "Compare_
Remainder_DB".
                                                                                %FB7
                   SUB
                                                                                                                          #Square2
                                                                                                         IsSmaller
#UpRight5
                                                                                                                                           #UpRight6
                                                                                             ENO
                                                                                                                                             -( s }-
                                                                    · EN
#Current_block — IN1
                       OUT — #Square2
                                                         #Square3 — SInt1
                                                                                          IsBigger → false
          42 — IN2
                                                        #Square2 — SInt2
                                                                                         IsSmaller → false
                                                               8 — Divide
```

Network 7:

Calculate possible index in the Up-right direction and set truth value UpRight7

```
#UpRight6
                EN - ENO
          64 — IN 📲 OUT1 — #Square2
                                                                                      %DB7
                                                                                 "Compare_
Remainder_DB"
                                                                                                             "Compare_
Remainder_DB".
IsSmaller
                    SUB
                                                                                     %FB7
                                                                                                                                   #Square1
#UpRight6
                                                                              "Compare_Remainder"
                                                                                                                                                     #UpRight7
                                                                                                    ENO
                                                                                                                                    SInt
#Current_block -
                                                                                                 IsBigger → false
                IN1
                        OUT — #Square1
                                                             #Square2 — SInt1
          49 — IN2
                                                             #Square1 — SInt2
                                                                                                IsSmaller ─Ifalse
                                                                    8 — Divider
```

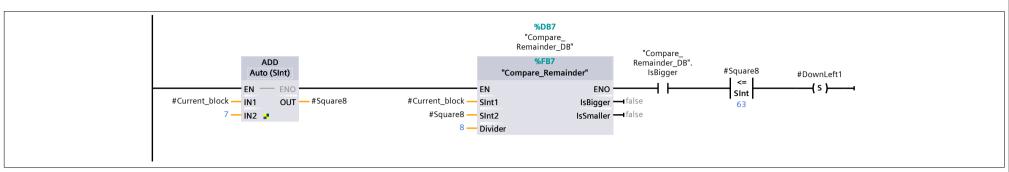
Network 8:

Reset value if no move set

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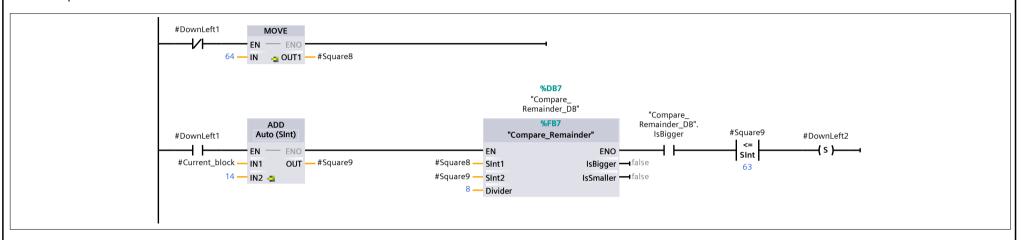
Network 9:

Calculate possible index in the Down-left direction and set truth value DownLeft1



Network 10:

Calculate possible index in the Down-left direction and set truth value DownLeft2



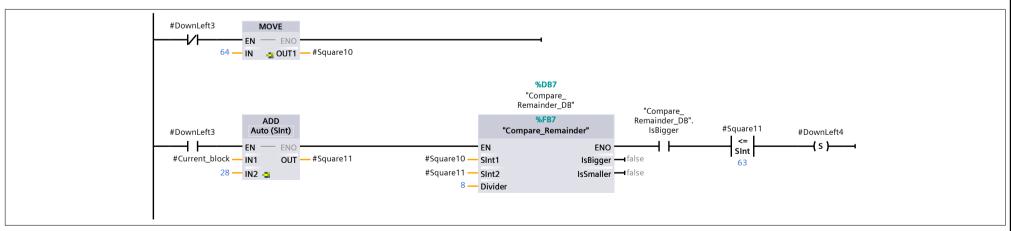
Network 11:

Calculate possible index in the Down-left direction and set truth value DownLeft3

```
MOVE
#DownLeft2
               EN - ENO
          64 — IN POUT1 — #Square9
                                                                         "Compare_
Remainder_DB"
                                                                                                  "Compare_
Remainder_DB".
                                                                           %FB7
                 ADD
                                                                                                                     #Square10
                Auto (SInt)
                                                                       "Compare_Remainder"
                                                                                                     IsBigger
                                                                                                                                        -( s )-
               EN - ENO
                                                                 - EN
                                                                                         ENO '
                                                                                                                       SInt
#Current_block — IN1 OUT — #Square10
                                                      #Square9 — SInt1
                                                                                       IsBigger → false
          21 — IN2 👪
                                                      #Square10 — SInt2
                                                                                      IsSmaller ─Ifalse
                                                             8 — Divider
```

Network 12:

Calculate possible index in the Down-left direction and set truth value DownLeft4



Network 13:

Calculate possible index in the Down-left direction and set truth value DownLeft5

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```
#DownLeft4
                EN - ENO
          64 — IN 📲 OUT1 — #Square11
                                                                                %DB7
                                                                            "Compare_
Remainder_DB"
                                                                                                      "Compare_
Remainder_DB".
                                                                                %FB7
                   ADD
                                                                          "Compare_Remainder"
                                                                                                         IsBigger
                                                                                                                          #Square12
#DownLeft4
                                                                                                                                           #DownLeft5
                                                                                                                            SInt
                                                                                           IsBigger — false
#Current_block —
               OUT — #Square12
                                                        #Square11 — SInt1
                                                        #Square12 — SInt2
          35 — IN2 📲
                                                                                          IsSmaller ─Ifalse
                                                                8 — Divider
```

Network 14:

Calculate possible index in the Down-left direction and set truth value DownLeft6

```
#DownLeft5
                EN - ENO
          64 — IN _ OUT1 — #Square12
                                                                                  %DB7
                                                                              "Compare_
Remainder_DB"
                                                                                                        "Compare_
Remainder_DB".
                                                                                 %FB7
                    ADD
                                                                                                                             #Square13
#DownLeft5
                  Auto (SInt)
                                                                           "Compare_Remainder"
                                                                                                            IsBigger
                                                                                                                                              #DownLeft6
                                                                      EN
                                                                                               ENO ·
                                                                                                                                                 -( s )-
#Current_block — IN1 OUT — #Square13
                                                                                            IsBigger → false
                                                         #Square12 — SInt1
                                                         #Square13 — SInt2
          42 — IN2 🝱
                                                                                            IsSmaller ─Ifalse
                                                                 8 — Divider
```

Network 15:

Calculate possible index in the Down-left direction and set truth value DownLeft7

```
#DownLeft6
                - EN --- ENO -
           64 — IN • OUT1 — #Square13
                                                                                   %DB7
                                                                               "Compare_
Remainder_DB"
                                                                                                          "Compare_
Remainder_DB".
                                                                                   %FB7
                    ADD
                                                                                                                               #Square14
                                                                                                             ls Bigger
#DownLeft6
                                                                                                                                                #DownLeft7
                                                                                                                                SInt
                                                                                              IsBigger ─ false
#Current_block — IN1 OUT — #Square14
                                                          #Square13 — SInt1
                                                          #Square14 — SInt2
           49 — IN2 📲
                                                                                             IsSmaller ─Ifalse
                                                                  8 — Divider
```

Network 16:

Reset value if no move set

```
#DownLeft7
EN ENO
OUT1
#Square14
```

Network 17:

Check squares for conditions of takeover and take over squares if #Only_check is set to 0.

Totally Integrated **Automation Portal** #Take_Over_ UpRight %FB2 "Take_Over" ENO -- EN #Rival_color — Rival_color Done ─Ifalse #Current_color — Current_color #Square7 — Square1 #Square6 — Square2 #Square5 — Square3 #Square4 — Square4 #Square3 — Square5 #Square2 — Square6 #Square1 — Square7 #UpRight1 — Move1 #UpRight2 — Move2 #UpRight3 — Move3 #UpRight4 — Move4 #UpRight5 — Move5 #UpRight6 — Move6 #UpRight7 — Move7 #Current_block — Current_block #Only_check — Only_check #Take_Over_ DownLeft %FB2 #Take_Over_ UpRight.Done "Take_Over" - EN ENO -Done →#Finish #Rival_color — Rival_color #Current_color — Current_color #Square8 — Square1 #Square9 — Square2 #Square10 — Square3 #Square11 — Square4 #Square12 — Square5 #Square13 — Square6 #Square14 — Square7 #DownLeft1 — Move1 #DownLeft2 — Move2 #DownLeft3 — Move3 #DownLeft4 — Move4 #DownLeft5 — Move5 #DownLeft7 — Move7 #Current_block — Current_block #Only_check — Only_check

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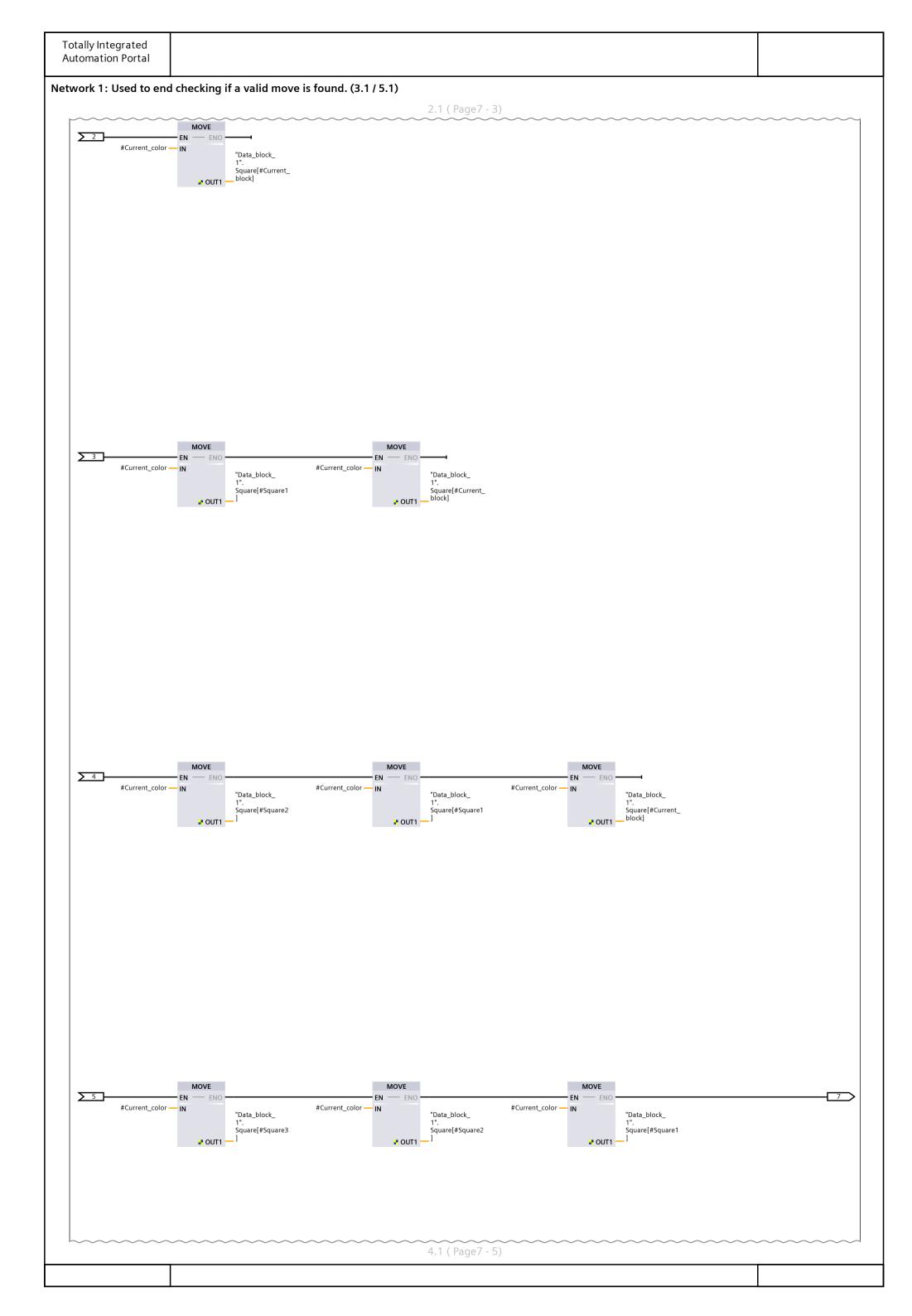
Take_Over [FB2]

Take_Over Prop	erties						
General							
Name	Take_Over	Number	2	Type	FB	Language	LAD
Numbering	Automatic						
Information							
Title		Author		Comment		Family	
Version	0.1	User-defined ID					

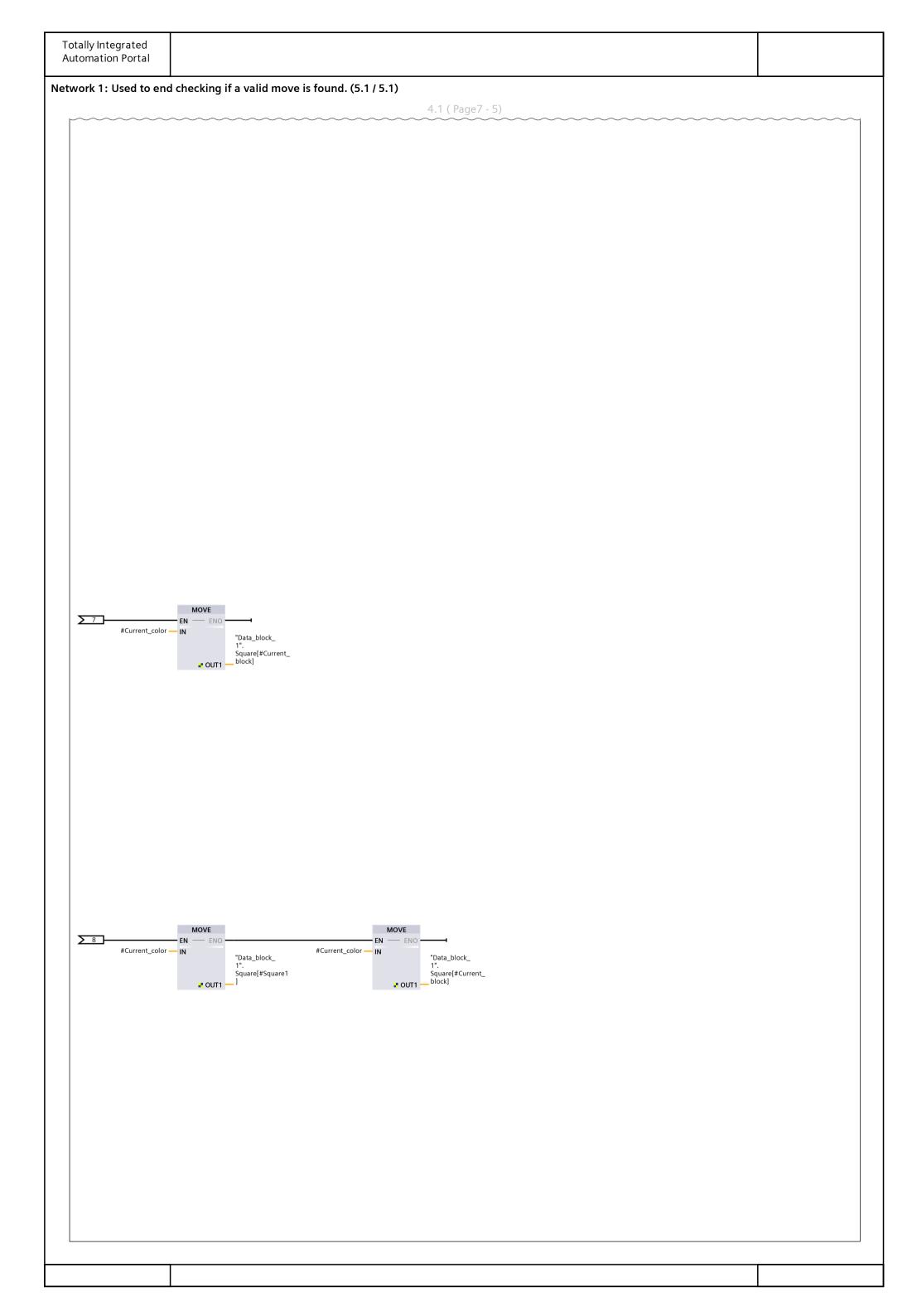
Input	
Current_color SInt 0 Non-retain True True False Square1 SInt 0 Non-retain True True False Square2 SInt 0 Non-retain True True False Square3 SInt 0 Non-retain True True False Square4 SInt 0 Non-retain True True False Square5 SInt 0 Non-retain True True False Square6 SInt 0 Non-retain True True False Square7 SInt 0 Non-retain True True False Move1 Bool false Non-retain True True False Move2 Bool false Non-retain True True False Move4 Bool false Non-retain True True False Move6 Bool <th></th>	
Current_color Sint 0 Non-retain True True False Square1 Sint 0 Non-retain True True False Square2 Sint 0 Non-retain True True False Square3 Sint 0 Non-retain True True False Square4 Sint 0 Non-retain True True False Square5 Sint 0 Non-retain True True False Square6 Sint 0 Non-retain True True False Square7 Sint 0 Non-retain True True False Move1 Bool false Non-retain True True False Move2 Bool false Non-retain True True False Move4 Bool false Non-retain True True False Move6 Bool <td></td>	
Square1 SInt 0 Non-retain True True False Square2 SInt 0 Non-retain True True False Square3 SInt 0 Non-retain True True False Square4 SInt 0 Non-retain True True False Square5 SInt 0 Non-retain True True False Square6 SInt 0 Non-retain True True False Square7 SInt 0 Non-retain True True False Move1 Bool false Non-retain True True False Move2 Bool false Non-retain True True False Move3 Bool false Non-retain True True False Move5 Bool false Non-retain True True False Move6 Bool	
Square2 SInt 0 Non-retain True True False Salse Square3 SInt 0 Non-retain True True False Salse Salse Square4 SInt 0 Non-retain True True True False Salse Sal	
Square3 SInt 0 Non-retain True True True False Square4 SInt 0 Non-retain True True True False Square5 SInt 0 Non-retain True True True False Square6 SInt 0 Non-retain True True True False Square7 SInt 0 Non-retain True True True False Move1 Bool false Non-retain True True True False Move2 Bool false Non-retain True True True False Move3 Bool false Non-retain True True False Move4 Bool false Non-retain True True False Move5 Bool false Non-retain True True False Move7 Bool false Non-retain True True False Current_block Sint 0 Non-retain True True False Only_check Bool false Non-retain True True<	
Square4 SInt 0 Non-retain True True False Square5 SInt 0 Non-retain True True True False Square6 SInt 0 Non-retain True True True False Square7 SInt 0 Non-retain True True True False Move1 Bool false Non-retain True True True False Move2 Bool false Non-retain True True False Move3 Bool false Non-retain True True False Move4 Bool false Non-retain True True False Move5 Bool false Non-retain True True False Move6 Bool false Non-retain True True False Move7 Bool false Non-retain True True False Current_block SInt 0 Non-retain True True False Only_check Bool false Non-retain True True False VOutput Done Bool false Non-retain True True False	
Square5 SInt 0 Non-retain True True False Square6 SInt 0 Non-retain True True True False Square7 SInt 0 Non-retain True True True False Square7 SInt 0 Non-retain True True True False Move1 Bool false Non-retain True True True False Move2 Bool false Non-retain True True True False Move3 Bool false Non-retain True True True False Move4 Bool false Non-retain True True True False Move5 Bool false Non-retain True True True False Move6 Bool false Non-retain True True True False Move7 Bool false Non-retain True True False Move7 True Sool false Non-retain True True False Move7 Bool false Non-retain True True False Sool Move7 Bool false Non-retain True True False False Move7 Sool false Non-retain True True False Move7 Sool false Move7 Sool false Non-retain True True False Move7 Sool false	
Square6 SInt 0 Non-retain True True False Square7 SInt 0 Non-retain True True True False Square7 SInt 0 Non-retain True True True False Move1 Bool false Non-retain True True True False Move2 Bool false Non-retain True True True False Move3 Bool false Non-retain True True True False Move4 Bool false Non-retain True True True True False Move5 Bool false Non-retain True True True False Move6 Bool false Non-retain True True True False Move7 Gurrent_block SInt O Non-retain True True True False Move7 Move7 Bool false Non-retain True True True False Move7 True Move7 Bool false Non-retain True True True False Move7 True Move7 Bool false Non-retain True True True False Move7 True Move7 False Non-retain True True True False Move7 True Move7 False Non-retain True True True False Move7 True Move7 False Non-retain True True True False Move7 False Non-retain True True True False Move7 False Move7 False Non-retain True True True False Move7 False Move7 False Non-retain True True True False Move7	
Square7SIntONon-retainTrueTrueTrueFalseMove1BoolfalseNon-retainTrueTrueTrueFalseMove2BoolfalseNon-retainTrueTrueTrueFalseMove3BoolfalseNon-retainTrueTrueTrueFalseMove4BoolfalseNon-retainTrueTrueTrueFalseMove5BoolfalseNon-retainTrueTrueTrueFalseMove6BoolfalseNon-retainTrueTrueTrueFalseCurrent_blockSIntONon-retainTrueTrueTrueFalseOnly_checkBoolfalseNon-retainTrueTrueTrueFalseOutputTrueTrueTrueTrueTrueFalse	
Move1BoolfalseNon-retainTrueTrueTrueFalseMove2BoolfalseNon-retainTrueTrueTrueFalseMove3BoolfalseNon-retainTrueTrueTrueFalseMove4BoolfalseNon-retainTrueTrueTrueFalseMove5BoolfalseNon-retainTrueTrueTrueFalseMove6BoolfalseNon-retainTrueTrueTrueFalseCurrent_blockSintONon-retainTrueTrueTrueFalseOnly_checkBoolfalseNon-retainTrueTrueTrueFalseOutputTrueNon-retainTrueTrueTrueFalse	
Move2BoolfalseNon-retainTrueTrueTrueFalseMove3BoolfalseNon-retainTrueTrueTrueFalseMove4BoolfalseNon-retainTrueTrueTrueFalseMove5BoolfalseNon-retainTrueTrueTrueFalseMove6BoolfalseNon-retainTrueTrueTrueFalseCurrent_blockSIntONon-retainTrueTrueTrueFalseOnly_checkBoolfalseNon-retainTrueTrueTrueFalse✓ OutputTrueTrueTrueTrueTrueFalse	
Move3BoolfalseNon-retainTrueTrueTrueFalseMove4BoolfalseNon-retainTrueTrueTrueFalseMove5BoolfalseNon-retainTrueTrueTrueFalseMove6BoolfalseNon-retainTrueTrueTrueFalseCurrent_blockSInt0Non-retainTrueTrueTrueFalseOnly_checkBoolfalseNon-retainTrueTrueTrueFalse✓ OutputToutputTrueTrueTrueTrueFalse	
Move4BoolfalseNon-retainTrueTrueTrueFalseMove5BoolfalseNon-retainTrueTrueTrueFalseMove6BoolfalseNon-retainTrueTrueTrueFalseMove7BoolfalseNon-retainTrueTrueTrueFalseCurrent_blockSInt0Non-retainTrueTrueTrueFalseOnly_checkBoolfalseNon-retainTrueTrueTrueFalse✓ OutputDoneBoolfalseNon-retainTrueTrueTrueFalse	
Move5BoolfalseNon-retainTrueTrueTrueFalseMove6BoolfalseNon-retainTrueTrueTrueFalseMove7BoolfalseNon-retainTrueTrueTrueFalseCurrent_blockSInt0Non-retainTrueTrueTrueFalseOnly_checkBoolfalseNon-retainTrueTrueTrueFalse✓ OutputDoneBoolfalseNon-retainTrueTrueTrueFalse	
Move6BoolfalseNon-retainTrueTrueTrueFalseMove7BoolfalseNon-retainTrueTrueTrueFalseCurrent_blockSInt0Non-retainTrueTrueTrueFalseOnly_checkBoolfalseNon-retainTrueTrueTrueFalse✓ OutputDoneBoolfalseNon-retainTrueTrueTrueFalse	
Move7BoolfalseNon-retainTrueTrueTrueFalseCurrent_blockSInt0Non-retainTrueTrueTrueFalseOnly_checkBoolfalseNon-retainTrueTrueTrueFalse✓ OutputDoneBoolfalseNon-retainTrueTrueTrueFalse	
Current_block SInt 0 Non-retain True True True False Only_check Bool false Non-retain True True True False ✓ Output Done Bool false Non-retain True True True False	
Only_check Bool false Non-retain True True True False ✓ Output Done Bool false Non-retain True True True False	
✓ Output Bool false Non-retain True True True False	
Done Bool false Non-retain True True False	
Static	
▼ Temp	
Temp1 Bool Use	ed to end checking if a lid move is found.
Temp2 Bool Use	ed to end checking if a lid move is found.
Temp3 Bool Use	ed to end checking if a lid move is found.
Temp4 Bool Use	ed to end checking if a lid move is found.
Temp5 Bool Use	ed to end checking if a lid move is found.
Constant	

Network 1: Used to end checking if a valid move is found.

Check and take over or mark squares if conditions for takeover met



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Network 1: Used to en	I checking if a valid move is found. (4.1 / 5.1)	
	3.1 (Page7 - 4)	
<u>√</u> 6]	MOVE	8
#Current_color	— IN #Current_color — IN #Current_color — IN #Data_block_ "Data_block_ 1".	
	AGUIT SQUINTS AGUIT AGUI	
	5.1 (Page7 - 6)	
	J.1 (1 aye/ - 0)	



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Network 2:			
Finish the program and setell higher subroutine tha	at it's finished		
		#Done	

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Horizontal_Check_DB [DB2]

Horizontal_Che	eck_DB Properties									
General										
Name	Horizontal_Check_DB	Number	2		Туре	DB		Langua	ige	DB
Numbering	Automatic									
Information										
Title		Author			Comment			Family		
Version	0.1	User-defined ID								
	•			ì	-					
Name	Data ty	oe Start val	ue	Retain	Accessible Wri	t- Visible in	Setpoint	Supervi-	Commer	nt

me	Data type	Start value	Retain	Accessible	Writ-	Visible in	Setpoint	Supervi-	Comment
				from HMI/OPC UA/Web API	able	HMI engi- neering	·	sion	
Input									
Current_block	SInt	0	False	True	True	True	False		
Rival_color	SInt	0	False		True		False		
Current_color	SInt	0	False		True		False		
Only_check	Bool	false	False		True		False		
Output			, 5.00	11.00					
<u> </u>	Bool	false	False	Two	T	T	False		
Finish	B 001	Taise	Faise	True	True	True	Faise		
InOut									
Static									
▼ Take_Over_Left	"Take_Over"		False	True	True	True	True		
▼ Input									
 Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False		True		False		
Square1	SInt	0	False		True		False		
Square2	SInt	0	False		True		False		
Square3	SInt	0	False		True		False		
Square4	SInt	0	False		True		False		
Square5	SInt	0	False		True		False		
Square6	SInt	0	False		True		False		
<u> </u>	SInt	0	False		True		False		
Square7	Bool	false	False		True		False		
Move1									
Move2	Bool	false	False		True		False		
Move3	Bool	false	False		True		False False		
Move4	Bool	false	False		True				
Move5	Bool	false	False		True		False		
Move6	Bool	false	False		True		False		
Move7	Bool	false	False		True		False		
Current_block	SInt	6-1	False		True		False		
Only_check	Bool	false	False	True	True	True	False		
▼ Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									
▼ Take_Over_Right	"Take_Over"		False	True	True	True	True		
▼ Input									
Rival_color	SInt	0	False	True	True	True	False		
Current_color	SInt	0	False		True		False		
Square1	SInt	0	False		True		False		
Square2	SInt	0	False		True		False		
·	SInt	0	False		True		False		
Square3	SInt	0	False		True		False		
Square4	SInt	0	False		True		False		
Square5	SInt	0	False		True		False		
Square6									
Square7	SInt	0 false	False		True		False		
Move1	Bool	false	False		True		False		
Move2	Bool	false	False		True		False		
Move3	Bool	false	False		True		False		
Move4	Bool	false	False		True		False		
Move5	Bool	false	False		True		False		
Move6	Bool	false	False		True		False		
Move7	Bool	false	False		True		False		
Current_block	SInt	0	False		True		False		
Only_check	Bool	false	False	True	True	True	False		
▼ Output									
Done	Bool	false	False	True	True	True	False		
InOut									
Static									

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NE-SW_Check_DB [DB3]

neral		11										
ıme ımbering	NE-SW_Check_DB Automatic	Numb	er	3		Туре	DI	В		Langua	ge	DB
ormation	Automatic											
le 	0.1	Autho				Comment				Family		
ersion	0.1		efined ID									
ame		Data type	Start val	ue	Retain	Accessible from HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Commen	t
Input												
Current_	olock	SInt	0		False	True	True	True	False			
Rival_col		SInt	0		False	True	True		False			
Current_		SInt	0		False	True	True		False			
Only_che	ck	Bool	false		False	True	True	True	False			
Output		David	£ 1.		F 1-	T	T	T .	F 1-			
Finish InOut		Bool	false		False	True	True	irue	False			
Static												
▼ Take_Ove	ar UnRight	"Take_Over"			False	True	True	True	True			
	a_opnigit	Take_Ovel			1 0136	nue	iiue	TIUC	iiue			
▼ Input		Class					-	T .				
	al_color	SInt	0		False	True	True True		False False			
	rent_color are1	SInt SInt	0		False False	True True	True		False			
	are2	SInt	0		False	True	True		False			
	are3	SInt	0		False	True	True		False			
	are4	SInt	0		False	True	True		False			
Squ	are5	SInt	0		False	True	True	True	False			
· ·	are6	SInt	0		False	True	True		False			
	are7	SInt	0		False	True	True		False			
Мо		Bool	false		False	True	True		False			
	ve2	Bool	false		False	True	True		False			
	ve3 ve4	Bool Bool	false false		False False	True True	True True		False False			
	ve5	Bool	false		False	True	True		False			
	ve6	Bool	false		False	True	True		False			
	ve7	Bool	false		False	True	True		False			
Cur	rent_block	SInt	0		False	True	True	True	False			
On	y_check	Bool	false		False	True	True	True	False			
Output	t											
Doi	ne	Bool	false		False	True	True	True	False			
InOut												
Static	Devel 6	UT-1 O			F-1	T	T	T	T			
	er_DownLeft	"Take_Over"			False	True	True	rrue	True			
▼ Input												
	al_color	SInt	0		False	True	True		False			
	rent_color	SInt	0		False	True	True		False			
	are1 are2	SInt SInt	0		False False	True True	True True		False False			
	are3	SInt	0		False	True	True		False			
	are4	SInt	0		False	True	True		False			
	are5	SInt	0		False	True	True		False			
	are6	SInt	0		False	True	True		False			
	are7	SInt	0		False	True	True		False			
Mo		Bool	false		False	True	True		False			
	ve2 ve3	Bool Bool	false false		False False	True True	True True		False False			
	ve4	Bool	false		False	True	True		False			
	ve5	Bool	false		False	True	True		False			
	ve6	Bool	false		False	True	True		False			
	ve7	Bool	false		False	True	True	True	False			
	rent_block	SInt	0		False	True	True		False			
	y_check	Bool	false		False	True	True	True	False			
▼ Outpu	t											
Doi		Bool	false		False	True	True	True	False			
InOut												
Static												

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NW-SE_Check_DB [DB4]

Only_check

Output

InOut Static

Done

Bool

Bool

false

false

	_DB Properties										
General Name Numbering	NW-SE_Check_D	DB N	umber		Туре	D	В		Langua	a ge D	В
nformation	ratomatic										
itle			uthor		Comment				Family		
ersion	0.1	U	ser-defined ID								
lame		Data type	Start valu	Retain	from	able	Visible in HMI engi- neering		Supervi- sion	Comment	
✓ Input						AFI					
 Current_	block	SInt	0	False	True	True	True	False			
Rival_co		SInt	0	False	True		True	False			
Current_		SInt	0	False	True		True	False			
Only_ch	eck	Bool	false	False	True	True	True	False			
Output											
Finish		Bool	false	False	True	True	True	False			
InOut											
▼ Static											
▼ Take_Ov	/er_UpLeft	"Take_Over	,п	False	True	True	True	True			
▼ Input											
	/al_color	SInt	0	False	True	True	True	False			
	rrent_color	SInt	0	False	True		True	False			
	uare1	SInt	0	False	True		True	False			
	uare2	SInt	0	False	True		True	False			
	uare3	SInt	0	False	True		True	False			
	uare4	SInt	0	False	True		True	False			
	uare5	SInt	0	False	True	True	True	False			
	uare6	SInt	0	False	True	True	True	False			
Sq	uare7	SInt	0	False	True	True	True	False			
Mo	ove1	Bool	false	False	True	True	True	False			
Mo	ove2	Bool	false	False	True	True	True	False			
Mo	ove3	Bool	false	False	True		True	False			
	ove4	Bool	false	False	True		True	False			
	ove5	Bool	false	False	True		True	False			
	ove6	Bool	false	False	True		True	False			
	ove7	Bool	false	False	True		True	False			
	irrent_block	SInt	6-10-	False	True		True	False			
	nly_check	Bool	false	False	True	True	True	False			
Outp					_	-	_				
	one	Bool	false	False	True	True	True	False			
InOut											
Statio	: ver_DownRight	"Take_Over	,11	False	True	Truo	True	True			
		rake_Over		raise	iiue	iiue	iiue	iiue			
▼ Input					-						
	/al_color	SInt	0	False	True		True	False			
	rrent_color	SInt	0	False	True		True	False			
	uare1	SInt	0	False	True		True	False			
	uare2	SInt	0	False	True		True	False			
	uare3	SInt SInt	0	False False	True True		True True	False False			
	uare4 uare5	SInt	0	False	True		True	False			
	uare6	SInt	0	False	True		True	False			
	uare7	SInt	0	False	True		True	False			
	ove1	Bool	false	False	True		True	False			
	ove2	Bool	false	False	True	_	True	False			
	ove3	Bool	false	False	True		True	False			
	ove4	Bool	false	False	True		True	False			
Мо	ove5	Bool	false	False	True	True	True	False			
Мо	ove6	Bool	false	False	True	True	True	False			
Мо	ove7	Bool	false	False	True	True		False			
	ırrent_block	SInt	0	False	True		True	False			
Or	nly check	Bool	false	False	True	True	True	False			

False

False

True

True

True True

True True

False

False

Vertical_Check_DB [DB5]

neral ne nbering	Vertical_Check_DB	Numk									
		INGILIE	er		Type	DE	В		Langua	ge	DB
	Automatic		'								
ormation		11									
e	0.4	Autho			Comment				Family		
sion	0.1	User-	defined ID								
ne		Data type	Start valu	Retain	Accessible	e Writ-	Visible in	Setpoint	Supervi-	Comme	ent
					from		HMI engi-		sion		
					HMI/OPC UA/Web	from HMI/	neering				
					API	OPC					
						UA/					
						Web					
						API					
Input											
Current_b		SInt	0	False	True	True		False			
Rival_colo	or	SInt	0	False	True	True	True	False			
Current_c	color	SInt	0	False	True	True		False			
Only_che	ck	Bool	false	False	True	True	True	False			
Output											
Finish		Bool	false	False	True	True	True	False			
InOut											
Static											
▼ Take_Ove	er Up	"Take_Over"		False	True	True	True	True			
	~٢	. 4.6_0 (6)		1 4136	1140	1146					
▼ Input											
	al_color	SInt	0	False	True	True		False			
	rent_color	SInt	0	False	True	True		False			
	are1	SInt	0	False	True	True		False			
	are2	SInt	0	False	True	True		False			
· ·	are3	SInt	0	False	True	True		False			
Squ	are4	SInt	0	False	True	True	True	False			
Squ	are5	SInt	0	False	True	True		False			
Squ	are6	SInt	0	False	True	True	True	False			
Squ	are7	SInt	0	False	True	True		False			
Mov	ve1	Bool	false	False	True	True		False			
Mov	ve2	Bool	false	False	True	True	True	False			
Mov	ve3	Bool	false	False	True	True	True	False			
Mov	ve4	Bool	false	False	True	True	True	False			
Mov	ve5	Bool	false	False	True	True	True	False			
Mov	ve6	Bool	false	False	True	True	True	False			
Mov	ve7	Bool	false	False	True	True	True	False			
Cur	rent_block	SInt	0	False	True	True	True	False			
Only	y_check	Bool	false	False	True	True	True	False			
Output	t										
Don	ne	Bool	false	False	True	True	True	False			
InOut			1 - 1 - 1								
Static											
▼ Take_Ove	er Down	"Take_Over"		False	True	True	True	True			
				1 4130	1.50	7.40					
▼ Input											
	al_color	SInt	0	False	True	True		False			
	rent_color	SInt	0	False	True	True		False			
	are1	SInt	0	False	True	True		False			
	are2	SInt	0	False	True	True		False			
	are3	SInt	0	False	True	True		False			
<u>.</u>	are4	SInt	0	False	True	True		False			
Squ	are5	SInt	0	False	True	True		False			
Squ	are6	SInt	0	False	True	True		False			
Squ	are7	SInt	0	False	True	True	True	False			
Mov	ve1	Bool	false	False	True	True	True	False			
Mov	ve2	Bool	false	False	True	True	True	False			
Mov	ve3	Bool	false	False	True	True	True	False			
Mov	ve4	Bool	false	False	True	True	True	False			
Mov	ve5	Bool	false	False	True	True	True	False			
Mov		Bool	false	False	True	True	True	False			
Mov		Bool	false	False	True	True	True	False			
	rent_block	SInt	0	False	True	True		False			
	y_check	Bool	false	False	True	True		False			
▼ Output	-			-							
		Bool	false	False	True	True	Truo	False			
Don	ie .	D OOI	iaise	raise	iiue	rrue	iiue	ı aıse			
InOut Static											

	t [FB6]											
oggle_bit Pro ieneral	perties											
lame Iumbering	Toggle_bit Automatic	N	lumber	6		Туре	FB			Lang	uage	SCL
nformation	Automatic	No.	·									
itle ersion	0.1		uthor ser-defined I	D		Comment				Fami	ly	
lame		Data type	Default	value	Retain		UA/Web API	able from HMI/ OPC UA/ Web	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment
Input								API				
Output												
✓ InOut Bit		Bool	false		Non-retair	า	True	True	True	False		
Static												
Temp Constant												
	:= NOT #Bit;	'	1				1	1		!		
ymbol		Address		Туре			Com	ment				
Bit				Bool								

mbering ormation e	Toggle_bit_DB Automatic		Number	6		Гуре	DI	3		Langua	ge [DB .
			Author			Comment				Family		
rsion	0.1	Data type		fined ID Start value	Retain	HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Commen	t.
Input Output							API					
InOut Bit		Bool	1	alse	False	True	True	True	False			

•	
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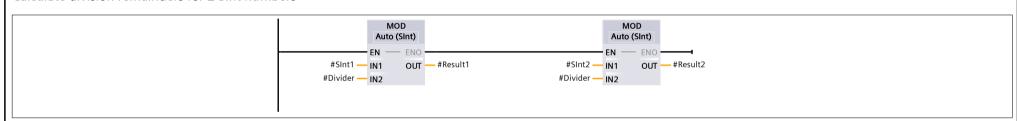
Compare_Remainder [FB7]

Compare_Rem	ainder Properties						
General							
Name	Compare_Remainder	Number	7	Туре	FB	Language	LAD
Numbering	Automatic						
Information							
Title		Author		Comment		Family	
Version	0.1	User-defined ID					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	HMI engi- neering		Supervi- sion	Comment
▼ Input									
SInt1	SInt	0	Non-retain	True	True	True	False		
SInt2	SInt	0	Non-retain	True	True	True	False		
Divider	SInt	0	Non-retain	True	True	True	False		
▼ Output									
IsBigger	Bool	false	Non-retain	True	True	True	False		
IsS maller	Bool	false	Non-retain	True	True	True	False		
InOut									
Static									
▼ Temp									
Result1	SInt								
Result2	SInt								
Constant									

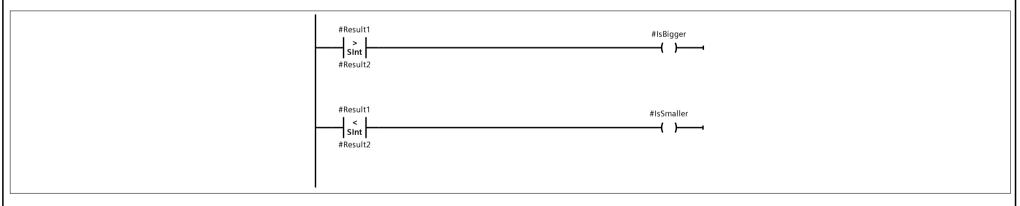
Network 1:

Calculate division remainders for 2 SInt numbers



Network 2:

Compare the remainders and give feedback on their relation.



Information Title	eneral ame umbering	Compare_Remainde	_DB N u	ımber	7	1	Туре	DE	3		Langua	ge	DB	
Version O.1 User-defined ID Version O.1 User-defined ID Version O.1 O	formation	, tatomatic	Δ.	ı th a u			Camanant				Family			
Input Sint1 Sint2 Sint2 Sint2 Sint2 Sint4 Sint4 O False True False True True False True False True True False True False True True False True False F		0.1					Comment				Family			
Find the solution of the solut	ame		Data type	Start val	ue	Retain	from HMI/OPC UA/Web API	able from HMI/ OPC UA/ Web	HMI engi-	Setpoint	Supervi- sion	Comme	nt	
SInt2 SInt 0 False True True True False Divider SInt 0 False True True True False Output IsBigger Bool false False True True True False IsSmaller Bool false False True True True False InOut	▼ Input													
Divider SInt 0 False True True False Output														
Output Seligger Bool false False True True True False Selse IsSmaller Bool false False True True True True False Selse InOut False True True True False Selse Sels														
IsBiggerBoolfalseFalseTrueTrueTrueFalseIsSmallerBoolfalseFalseTrueTrueTrueFalseInOutInoutInoutInoutInoutInoutInoutInoutInoutInout			JIIIL	U		raise	iiue	irue	iiue	raise				
IsSmaller Bool false False True True False InOut			Bool	false		False	True	True	True	False				
InOut														
Static														
	Static													

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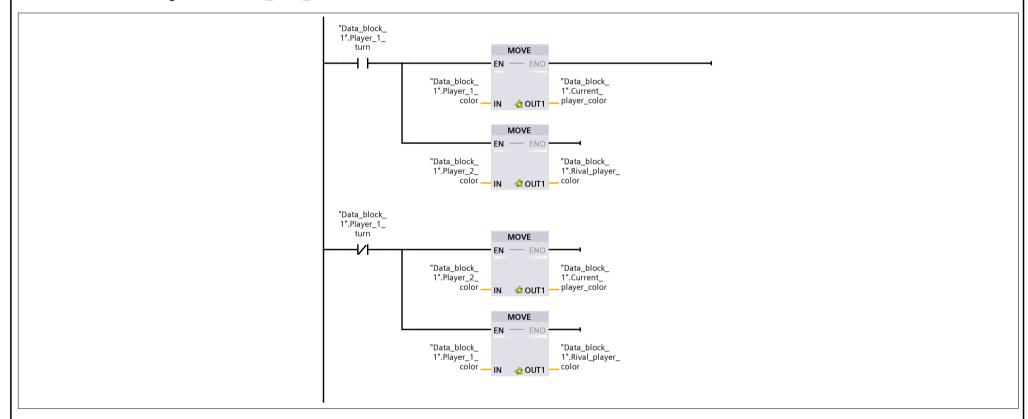
Set_Current_Color [FB8]

Set_Current_Color Properties										
General										
Name	Set_Current_Color	Number	8	Type	FB	Language	LAD			
Numbering	Automatic									
Information										
Title		Author		Comment		Family				
Version	0.1	User-defined ID								

Name	Data type	Default value	Retain	HMI/OPC UA/Web API	able	HMI engi- neering	Setpoint	Supervi- sion	Comment
Input									
Output									
InOut									
Static									
Temp									
Constant									

Network 1:

Set current color according to data in Data_block_1



Program blocks Set_Current_Color_DB [DB12] Set_Current_Color_DB Properties												
General				10		_						
Name Numbering	Set_Current_Color_ Automatic	DB	Number	12		Туре	DI	B 		Langua	ge [OB
nformation itle			Author			Comment				Family		
/ersion lame	0.1	Data type		fined ID Start value	Retain	Accessible	Writ-	Visible in	Setnoint	Supervi-	Commen	•
		Data type		ant value		from HMI/OPC UA/Web API	able	HMI engi- neering	Scipolit	sion		
Input Output												
InOut Static												

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Automation Portal	

Hint_And_Point_System [FB9]

Hint_And_Point	Hint_And_Point_System Properties										
General											
Name	Hint_And_Point_System	Number	9	Type	FB	Language	LAD				
Numbering	Automatic										
Information											
Title		Author		Comment		Family					
Version	0.1	User-defined ID									

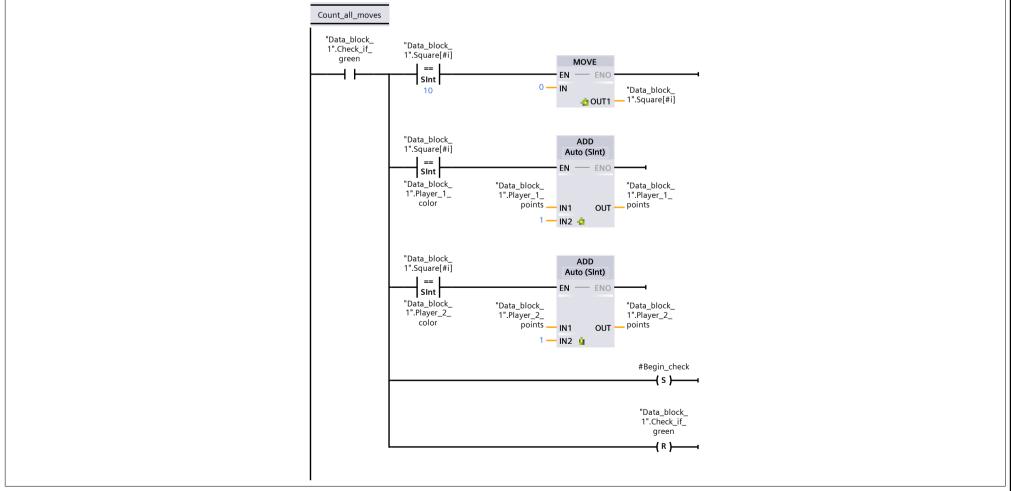
Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	HMI engi- neering	Setpoint	Supervi- sion	Comment
Input									
Output									
InOut									
Static									
▼ Temp									
i	SInt								
Current_block	SInt								
Current_block_begin_value	SInt								
Begin_check	Bool								
▼ Constant									
Only_check	Bool	true							

Network 1:

Init variables used for hint and point calculation

Network 2:

Check if current block is green (possible move) and calculate points based on current contents of Square[] array

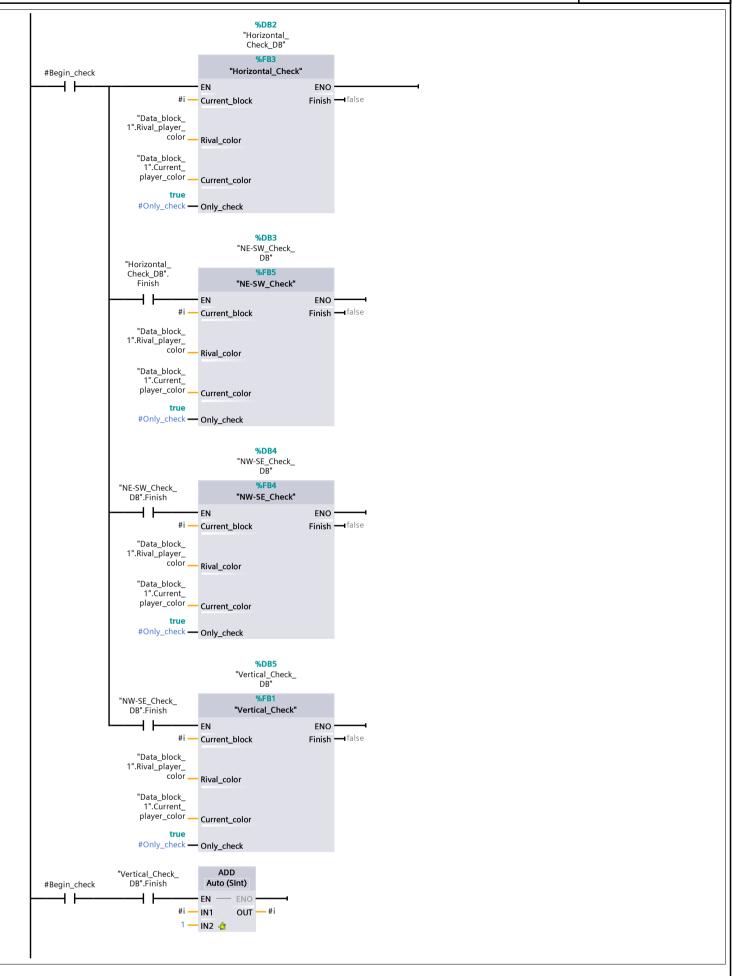


Network 3:

The same blocks that are used for taking over, except they are set to mark possible moves with the value of 10 in Square[] array (only checking)

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Network 4: Default false; tells the program whether last turn was invalid and current player has been toggled

Changes current player if there are no possible moves. Condition for ending the loop. If current player has been changed two times in a row there are no more possible moves and the game has to end.

Totally Integrated **Automation Portal** "Data_block_ 1".Possible_ moves "Data_block_ 1".Zero_move_ change #i #Begin_check >= SInt > SInt #Begin_check _(R)_ "Data_block_ 1".Possible_ moves "Data_block_ 1".Zero_move_ change "Data_block_ 1".Game_over -(s)-SInt #Begin_check %DB6
"Toggle_bit_DB"
%FB6 "Data_block_ 1".Zero_move_ change "Toggle_bit" ENO EN "Data_block_ 1".Player_1_ turn — Bit "Data_block_ 1".Zero_move_ change "Data_block_ 1".Check_if_ green RLO -**(** RET **)**--Network 5: Default false; check the board for green places (possible moves) Continues loop if current loop variable is less than the size of Square[] array "Data_block_ 1".Check_if_ green "Vertical_Check_ DB".Finish #Begin_check SInt Count_all_moves —**(** JMP **)**——

ieneral	nt_System_DB Proper									
lame Iumbering	Hint_And_Point_Sy Automatic	rstem_DB Nu	mber 8		Туре	DB		Langua	age [DB
nformation itle		Au	thor		Comment			Family	,	
ersion	0.1		er-defined ID					, y		
ıme		Data type	Start value	Retain	from	Writ- Visible able HMI en from neering HMI/ OPC UA/ Web API	gi-	Supervi- sion	Comment	
Input						AFI				
Output InOut										
Static										

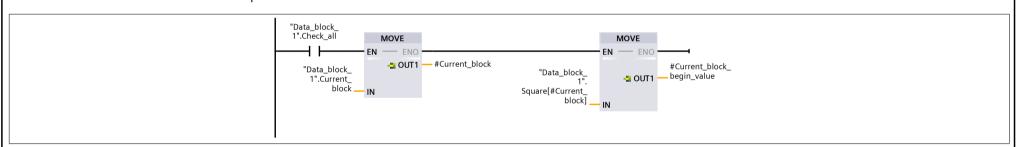
Totally Integrated Automation Portal		
Program blocks Check_And_Take_	Over_System [FB10]	

Check_And_Tak	Check_And_Take_Over_System Properties										
General											
Name	Check_And_Take_Over_Sys-	Number	10	Туре	FB	Language	LAD				
	tem										
Numbering	Automatic										
Information											
Title		Author		Comment		Family					
Version	0.1	User-defined ID									

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	HMI engi- neering	Setpoint	Supervi- sion	Comment
Input									
Output									
InOut									
Static									
▼ Temp									
Current_block	SInt								
Current_block_begin_value	SInt								
Check_4	Bool								
Check_3	Bool								
Check_2	Bool								
Check_1	Bool								
Check_finished	Bool								
Constant									

Network 1:

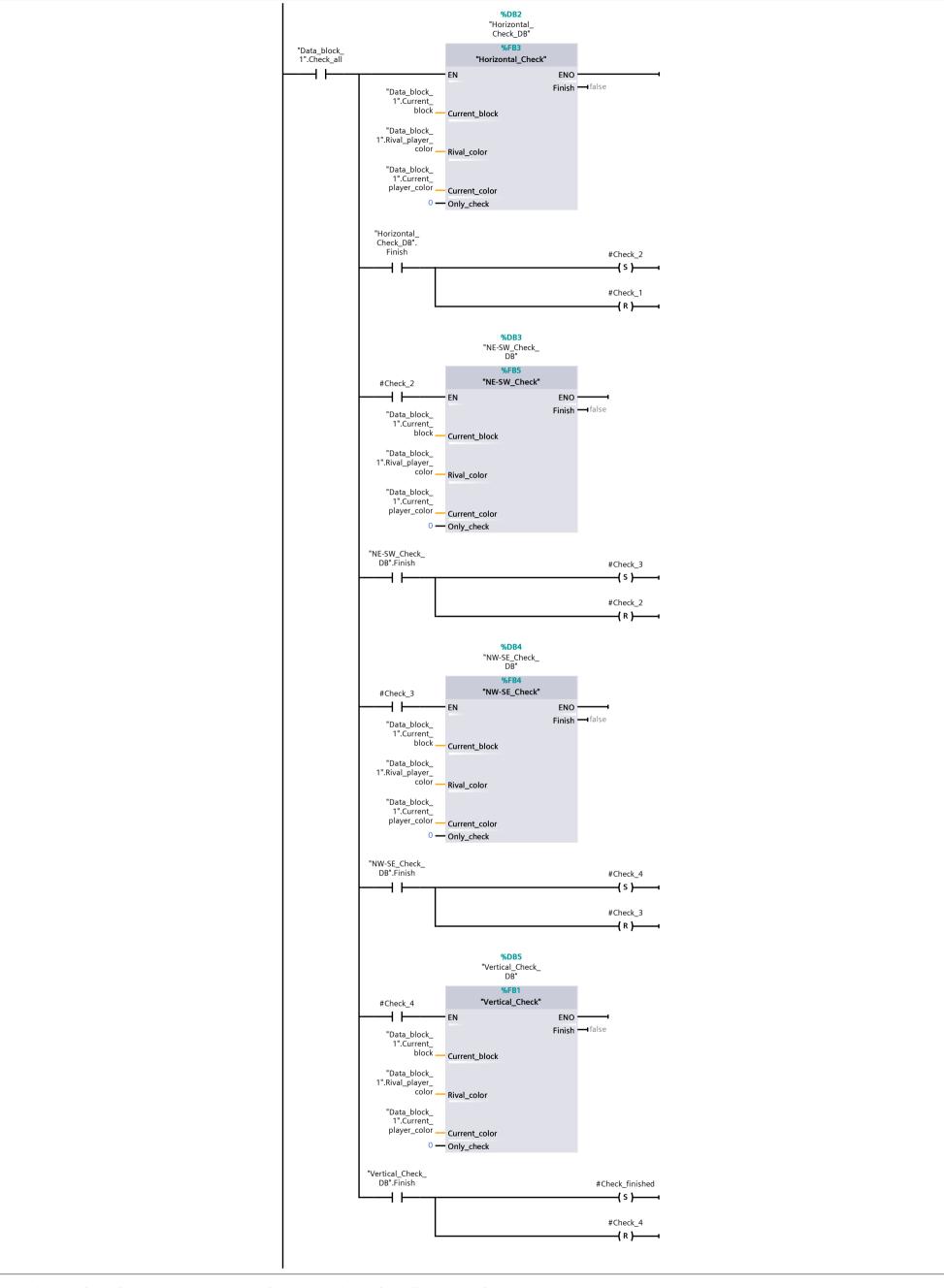
Save current index and value of clicked square



Network 2:

Perform checking in all directions and take over squares if conditions met. Checks are performed sequentially in order to reduce possible collisions of interest between functions.

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Network 3: Default false; check the board for green places (possible moves)

If checking in all directions has been finished check if a valid move was made, toggle current player, reset possible moves count and set Check_if_green in order to activate the hint system.

Totally Integrated **Automation Portal** "Data_block_ 1". Square[#Current_ block] %DB6
"Toggle_bit_DB"
%FB6
"Toggle_bit" "Data_block_ 1".Check_if_ green #Check_finished MOVE SInt #Current_block_begin_value EN ENO EN - ENO "Data_block_ 1".Player_1_ turn — Bit "Data_block_ 1".Possible_ — moves 0 — IN #Check_finished **--(** R **}-----**"Data_block_ 1".Check_all _(R)_

	Over_System_DB Prope											
te	heck_And_Take_Over_Sy em_DB	s- Numb	er	9		Туре)B		Langua	ge	DB
ring Au ation	utomatic											
0.	.1	Autho User-d	efined ID			Comment				Family		
	Data	type	Start valu	le	Retain	from	able from HMI/ OPC UA/ Web		Setpoint	Supervi- sion	Comme	nt
ıt							API					
put ut												
ic												

|--|

Save_Score [FB11]

Save_Score Properties										
General										
Name	Save_Score	Number	11	Туре	FB	Language	LAD			
Numbering	Automatic									
Information										
Title		Author		Comment		Family				
Version	0.1	User-defined ID								

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	HMI engi- neering	Setpoint	Supervi- sion	Comment
Input									
Output									
InOut									
Static									
▼ Temp									
Current_win_score	SInt								
Current_win_name	String								
Current_lose_name	String								
Current_lose_score	SInt								
Constant									

Network 1:

Save current scores to Last scores array

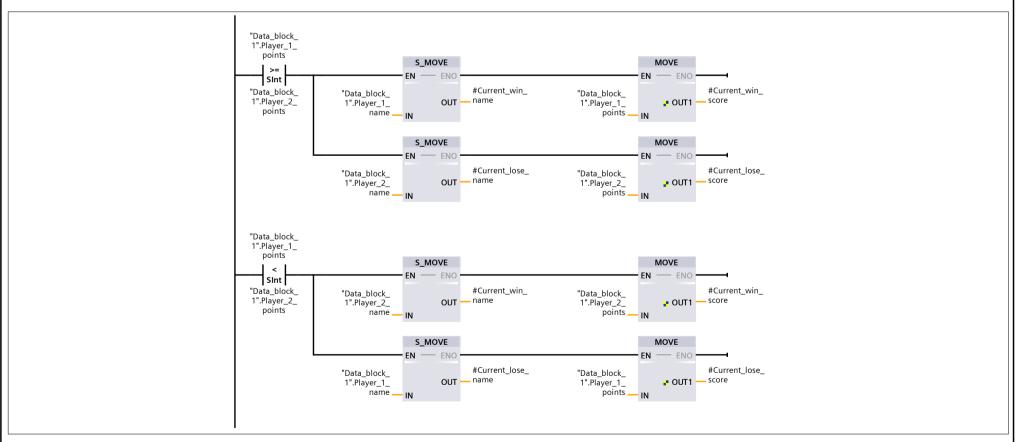
```
%DB10
"Last_Score_
Move_DB"

%FB12
"Last_Score_Move"

EN ENO
```

Network 2:

Check which player has won



Network 3:

Save High scores according to results from Network 2

		1
Totally Integrated Automation Portal		
	#Current_win_ name #Current_lose_ score #Current_lose_ score #Current_lose_ name #Current_lose_ name #Current_lose_ name #Current_lose_ name #Current_lose_ name Current_lose_ name #Current_lose_ name #Current_lose_ name	
Network 4:	<u>. </u>	
Set Scores_saved to true		
	"Data_block_ 1".Scores_ saved	

|--|

Last_Score_Move [FB12]

Last_Score_Move Properties							
General							
Name	Last_Score_Move	Number	12	Туре	FB	Language	LAD
Numbering	Automatic						
Information							
Title		Author		Comment		Family	
Version	0.1	User-defined ID					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	HMI engi- neering	Setpoint	Supervi- sion	Comment
Input									
Output									
InOut									
Static									
▼ Temp									
i	SInt								
Temp_points	SInt								
Temp_names	String								
Second_player	Bool								
Constant									

Network 1:

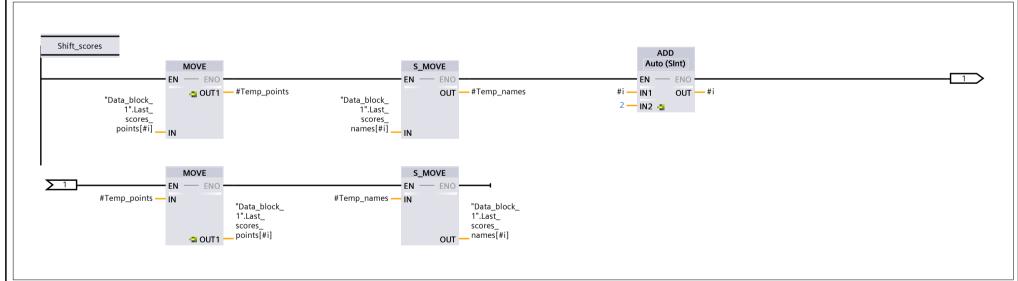
Start with player 1's score 4 matches ago



Network 2:

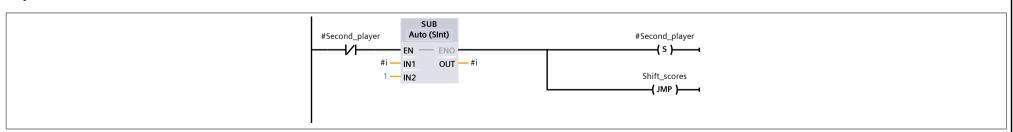
Shift all scores and names by 2 places (Player 1's scores and names)

Network 2:



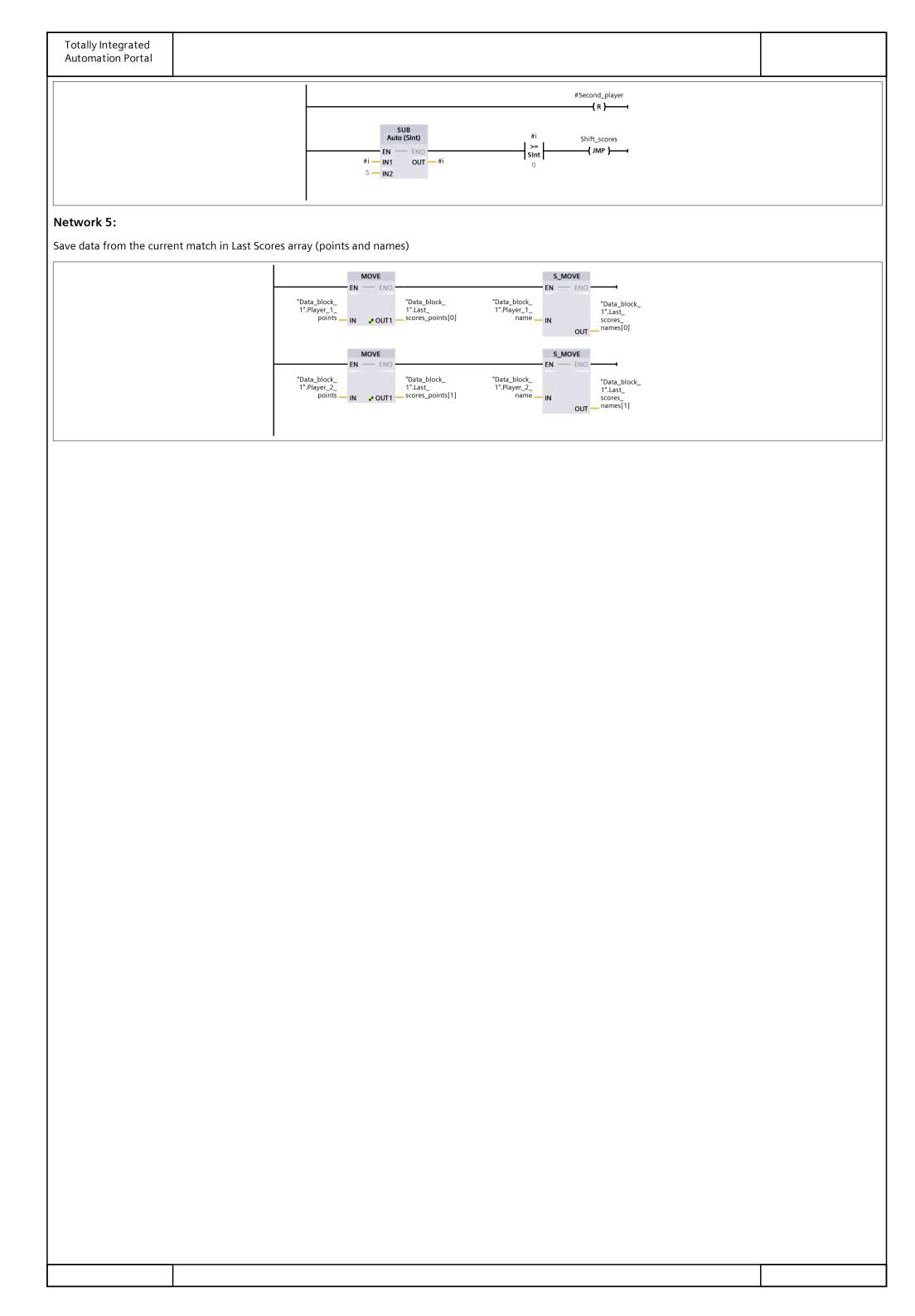
Network 3:

Player 2's scores and names



Network 4:

Go back to Player 1's more recent match score and name



amo	ove_DB Properties)B	mber 10		Type	DB		langu	ade D.	·
ame umbering	Last_Score_Move_D Automatic	งช Nu	mber 10		Туре	nR		Langua	age DE	5
formation tle			thor		Comment			Family		
ersion	0.1		er-defined ID							
me		Data type	Start value	Retain	from	Writ- Visible i able HMI end from neering HMI/ OPC UA/ Web API	gi-	Supervi- sion	Comment	
Input Output										
InOut										
Static										

	blocks	1								
Save_Score_DE	e_DB [DB11	1								
General Name	Save_Score_DB	B N	lumber 11		Туре	DB		Langua	age DB	3
Numbering Information	Automatic	,	idinoci 11		Турс	D		Langue	age D	
Title Version	0.1	A	uthor Iser-defined ID		Comment			Family	,	
Name	0.1	Data type		Retain	Accessible	Writ- Visible	in Setpoint	Supervi-	Comment	
valile		Бака (уре	Start value	Retail	from	able HMI ei	ngi-	sion	Comment	
Input										
Output InOut										
Static										

n Portal	grated	
	mation Portal	

Reset_Game [FB13]

Reset_Game P	roperties						
General							
Name	Reset_Game	Number	13	Туре	FB	Language	LAD
Numbering	Automatic						
Information							
Title		Author		Comment		Family	
Version	0.1	User-defined ID					
N		D-flt	lus Butain	_	- this wait William Cat		

 9	Data type	Default value	Retain	Accessible	Writ-	Visible in	Setpoint	Supervi-	Comment
	Data type	Delidate value	Retuil	from HMI/OPC UA/Web API	able	HMI engi- neering	Scipolit	sion	Comment
nput									
Output									
InOut Static									
Zero_array	Array[063] of SInt		Non-retain	False	False	False	False		
Zero_array[0]	SInt	0	Non-retain	False	False	False	False		
Zero_array[1]	SInt	0	Non-retain	False	False		False		
Zero_array[2]	SInt	0	Non-retain	False	False		False		
Zero_array[3]	SInt	0	Non-retain	False	False	False	False		
Zero_array[4]	SInt	0	Non-retain	False	False	False	False		
Zero_array[5]	SInt	0	Non-retain	False	False	False	False		
Zero_array[6]	SInt	0	Non-retain	False	False	False	False		
Zero_array[7]	SInt	0	Non-retain	False	False	False	False		
Zero_array[8]	SInt	0	Non-retain	False	False	False	False		
Zero_array[9]	SInt	0	Non-retain	False	False	False	False		
Zero_array[10]	SInt	0	Non-retain	False	False	False	False		
Zero_array[11]	SInt	0	Non-retain	False	False	False	False		
Zero_array[12]	SInt	0	Non-retain	False	False	False	False		
Zero_array[13]	SInt	0	Non-retain	False	False		False		
Zero_array[14]	SInt	0	Non-retain	False	False	False	False		
Zero_array[15]	SInt	0	Non-retain	False	False		False		
Zero_array[16]	SInt	0	Non-retain	False	False	False	False		
Zero_array[17]	SInt	0	Non-retain	False	False	False	False		
Zero_array[18]	SInt	0	Non-retain	False	False		False		
Zero_array[19]	SInt	0	Non-retain	False	False		False		
Zero_array[20]	SInt	0	Non-retain	False	False		False		
Zero_array[21]	SInt	0	Non-retain	False	False		False		
Zero_array[22]	SInt	0	Non-retain	False	False		False		
Zero_array[23]	SInt	0	Non-retain	False	False		False		
Zero_array[24]	SInt	0	Non-retain	False	False		False		
Zero_array[25]	SInt	0	Non-retain	False	False		False		
Zero_array[26]	SInt	0	Non-retain	False	False		False		
Zero_array[27]	SInt	0	Non-retain	False	False		False		
Zero_array[28]	SInt	0	Non-retain	False	False		False		
Zero_array[29]	SInt	0	Non-retain	False	False		False		
Zero_array[30]	SInt	0	Non-retain	False	False		False		
Zero_array[31]	SInt	0	Non-retain	False	False		False		
Zero_array[32]	SInt	0	Non-retain	False	False		False		
Zero_array[33]	SInt SInt	0	Non-retain	False False	False False		False False		
Zero_array[34]	Sint	0	Non-retain Non-retain	False	False		False		
Zero_array[35]	SInt	0	Non-retain Non-retain	False	False		False		
Zero_array[36]	SInt	0	Non-retain Non-retain	False	False		False		
Zero_array[37] Zero_array[38]	SInt	0	Non-retain	False	False		False		
Zero_array[39]	SInt	0	Non-retain	False	False		False		
Zero_array[39] Zero_array[40]	SInt	0	Non-retain	False	False		False		
Zero_array[41]	SInt	0	Non-retain	False	False		False		
Zero_array[42]	SInt	0	Non-retain	False	False		False		
Zero_array[43]	SInt	0	Non-retain	False	False		False		
Zero_array[44]	SInt	0	Non-retain	False	False		False		
Zero_array[45]	SInt	0	Non-retain	False	False		False		
Zero_array[46]	SInt	0	Non-retain	False	False		False		
Zero_array[47]	SInt	0	Non-retain	False	False		False		
Zero_array[48]	SInt	0	Non-retain	False	False		False		
Zero_array[49]	SInt	0	Non-retain	False	False		False		
Zero_array[50]	SInt	0	Non-retain	False	False		False		
Zero_array[51]	SInt	0	Non-retain	False	False		False		
Zero_array[52]	SInt	0	Non-retain	False	False		False		
Zero_array[53]	SInt	0	Non-retain	False	False		False		
Zero_array[54]	SInt	0	Non-retain	False	False		False		

Totally Integrated Automation Portal							
Name	Data type	Default value	Retain	from a HMI/OPC f UA/Web l	Writ- Visible in able HMI engi- from neering HMI/ OPC	Supervi- sion	Comment

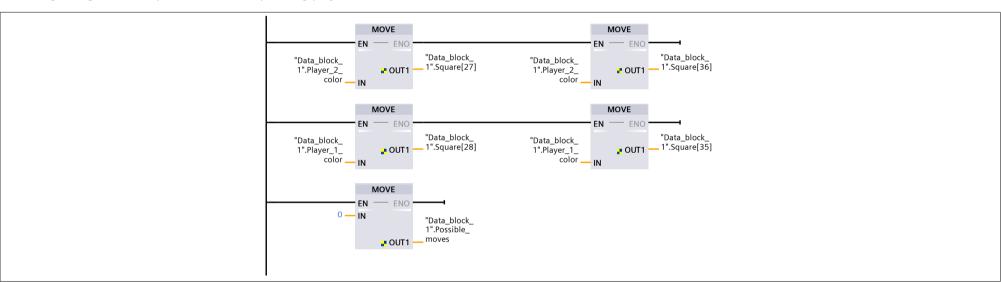
Name	раца туре	Default value	Retain		able	HMI engi- neering		sion	Comment
Zero_array[55]	SInt	0	Non-retain	False	False	False	False		
Zero_array[56]	SInt	0	Non-retain	False	False	False	False		
Zero_array[57]	SInt	0	Non-retain	False	False	False	False		
Zero_array[58]	SInt	0	Non-retain	False	False	False	False		
Zero_array[59]	SInt	0	Non-retain	False	False	False	False		
Zero_array[60]	SInt	0	Non-retain	False	False	False	False		
Zero_array[61]	SInt	0	Non-retain	False	False	False	False		
Zero_array[62]	SInt	0	Non-retain	False	False	False	False		
Zero_array[63]	SInt	0	Non-retain	False	False	False	False		
▼ Temp									
i	SInt								
Constant									

Network 1:

Fill the Square[] array with zeros

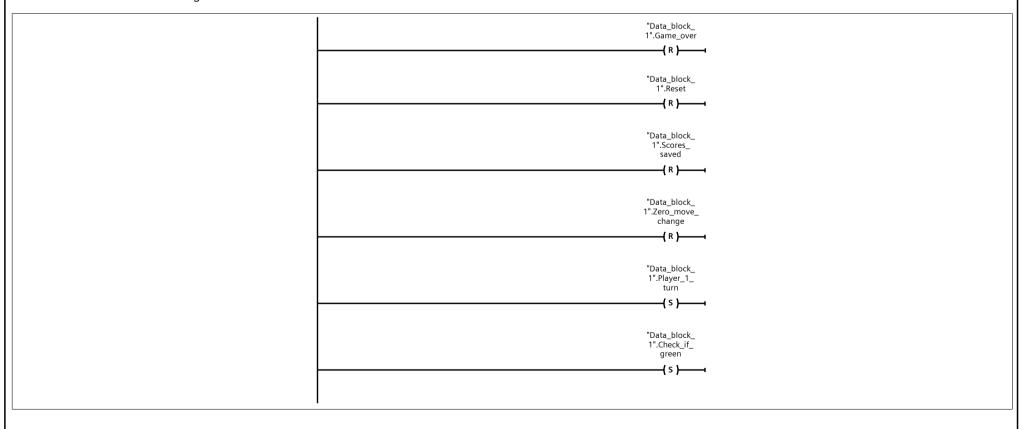
Network 2:

Fill in beginning, default squares with corresponding player color values



Network 3: Default false; tells the PLC if a game has finished

Set default variables for a new game



y Integrated	
tomation Portal	

Reset_Game_DB [DB13]

Reset_Game_D	B Properties						
General							
Name	Reset_Game_DB	Number	13	Туре	DB	Language	DB
Numbering	Automatic						
Information							
Title		Author		Comment		Family	
Version	0.1	User-defined ID					

		'	'							
ne		Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	able	Visible in HMI engi- neering	Setpoint	Supervi- sion	Comment
Input										
Output										
InOut										
Static										
▼ Zero_ar	ray	Array[063] of SInt		False	False	False	False	False		
Zero_	_array[0]	SInt	0	False	False	False	False	False		
Zero_	_array[1]	SInt	0	False	False	False	False	False		
Zero_	_array[2]	SInt	0	False	False	False	False	False		
Zero_	_array[3]	SInt	0	False	False	False	False	False		
Zero_	_array[4]	SInt	0	False	False	False	False	False		
Zero_	_array[5]	SInt	0	False	False	False	False	False		
Zero	_array[6]	SInt	0	False	False	False	False	False		
	_array[7]	SInt	0	False	False	False	False	False		
	_array[8]	SInt	0	False	False		False	False		
	_array[9]	SInt	0	False	False		False	False		
	_array[5] _array[10]	SInt	0	False	False		False	False		
	_array[10] _array[11]	SInt	0	False	False	False		False		
	_array[11] _array[12]	SInt	0	False	False		False	False		
	-									
	_array[13]	SInt	0	False	False		False	False		
	_array[14]	SInt	0	False	False		False	False		
	_array[15]	SInt	0	False	False		False	False		
	_array[16]	SInt	0	False	False		False	False		
	_array[17]	SInt	0	False	False		False	False		
Zero_	_array[18]	SInt	0	False	False	False	False	False		
Zero_	_array[19]	SInt	0	False	False	False	False	False		
Zero_	_array[20]	SInt	0	False	False	False	False	False		
Zero_	_array[21]	SInt	0	False	False	False	False	False		
	_array[22]	SInt	0	False	False	False	False	False		
	_array[23]	SInt	0	False	False	False	False	False		
	_array[24]	SInt	0	False	False		False	False		
	_array[25]	SInt	0	False	False	False		False		
	_array[26]	SInt	0	False	False		False	False		
	_array[20] _array[27]	SInt	0	False	False		False	False		
	_array[27] _array[28]	SInt	0	False	False		False	False		
	-	SInt	0	False	False		False	False		
	_array[29]									
	_array[30]	SInt	0	False	False		False	False		
	_array[31]	SInt	0	False	False		False	False		
	_array[32]	SInt	0	False	False		False	False		
	_array[33]	SInt	0	False	False		False	False		
	_array[34]	SInt	0	False	False	False		False		
	_array[35]	SInt	0	False	False		False	False		
Zero_	_array[36]	SInt	0	False	False		False	False		
Zero_	_array[37]	SInt	0	False	False	False	False	False		
Zero_	_array[38]	SInt	0	False	False	False	False	False		
Zero	_array[39]	SInt	0	False	False	False	False	False		
	_array[40]	SInt	0	False	False	False	False	False		
	_array[41]	SInt	0	False	False	False	False	False		
	_array[42]	SInt	0	False	False		False	False		
	_array[43]	SInt	0	False	False		False	False		
	_array[44]	SInt	0	False	False		False	False		
	_array[45]	SInt	0	False	False		False	False		
	_array[46]	SInt	0	False	False		False	False		
	_array[40] _array[47]	SInt	0	False	False		False	False		
	_array[47] _array[48]	SInt	0	False	False		False	False		
							False	False		
	_array[49]	SInt	0	False	False					
	_array[50]	SInt	0	False	False		False	False		
	_array[51]	SInt	0	False	False	_	False	False		
	_array[52]	SInt	0	False	False	False		False		
	_array[53]	SInt	0	False	False		False	False		
7ero	_array[54]	SInt	0	False	False	False	False	False		

Totally Integrated Automation Portal										
Name	Data type	Start value	Retain	HMI/OPC UA/Web API	able	HMI engi-	Setpoint	Supervi- sion	Comment	
Zero_array[55]	SInt	0	False		False	False	False			
Zero_array[56]	SInt	0	False		False		False			
Zero_array[57]	SInt	0	False		False		False			
Zero_array[58]	SInt	0	False		False		False			
Zero_array[59]	SInt	0	False		False		False			
Zero_array[60]	SInt SInt	0	False False		False		False False			
Zero_array[61] Zero_array[62]	SInt	0	False		False False		False			
Zero_array[63]	SInt	0	False	False	False		False			

|--|

High_Score_Move [FB14]

High_Score_M	ove Properties						
General							
Name	High_Score_Move	Number	14	Type	FB	Language	LAD
Numbering	Automatic						
Information							
Title		Author		Comment		Family	
Version	0.1	User-defined ID					

Name	Data type	Default value	Retain	Accessible from HMI/OPC UA/Web API	able	HMI engi- neering		Supervi- sion	Comment
▼ Input									
Current_win_score	SInt	0	Non-retain	True	True	True	False		
Current_win_name	String	11	Non-retain	True	True	True	False		
Current_lose_score	SInt	0	Non-retain	True	True	True	False		
Current_lose_name	String	П	Non-retain	False	False	False	False		
Output									
InOut									
Static									
▼ Temp									
i	SInt								
j	SInt								
Temp_points	SInt								
Temp_names	String								
Second_player	Bool								
High_score_found	Bool								
Constant									

Network 1:

Initialize first loop variable

```
MOVE

EN ENO

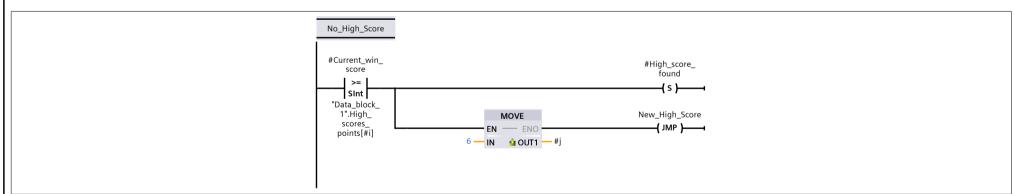
IN № OUT1

#High_score_
found

R }
```

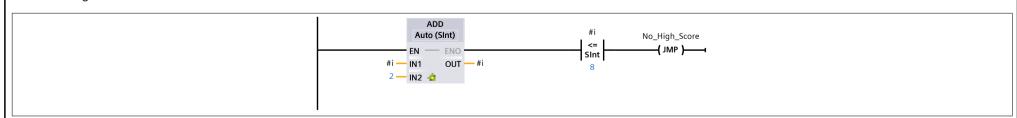
Network 2:

If a new high score is found initialize second loop variable



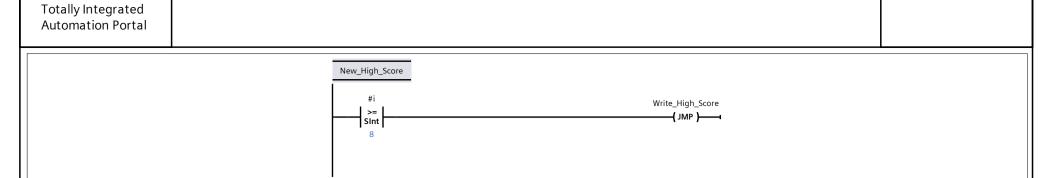
Network 3:

if no new high score is found move on to next record



Network 4:

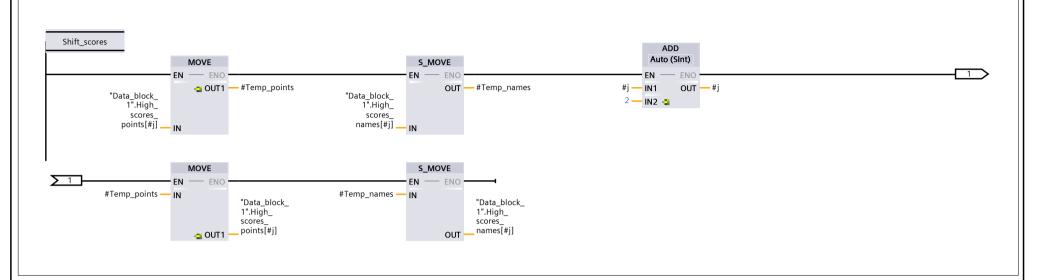
If current high score will only replace the last record of array skip the loop



Network 5:

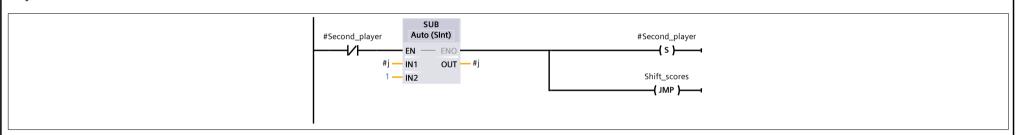
Shift all scores lower than current high score and names by 2 places (Player 1's scores and names)

Network 5:



Network 6:

Player 2's scores and names



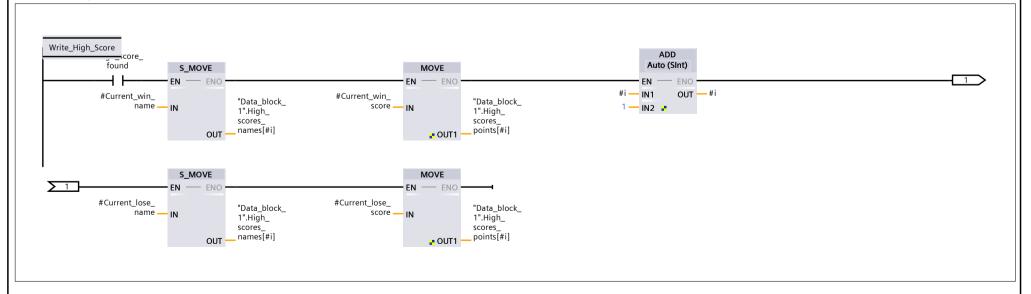
Network 7:

Go back to Player 1's more recent match score and name (move up a row). if calculated second loop variable is greater or equal than first loop variable, continue loop

Network 8:

Move current high score to corresponding place in high scores array

Network 8:



neral me mbering	High_Score_Move_I Automatic	DB Nu	mber	14	-	Гуре	DE	В		Langua	ge	DB	
ormation le rsion	0.1		thor er-defined ID			Comment				Family			
me		Data type	Start va	ue	Retain	HMI/OPC UA/Web API	able from HMI/ OPC UA/ Web	HMI engi- neering	Setpoint	Supervi- sion	Comme	nt	
Input							API						
	win_score	SInt	0		False	True	True	True	False				
Current_v	win_name	String	11		False		True		False				
		SInt	0		False		True		False				
	ose_name	String	11		False	False	False	ralse	False				
Output InOut													
Static													