

PLCs in automated material handling systems

SAGS presentation 12-2-2008

Gert Maas

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AGENDA

- PLC appliances in VI systems
- FSC
- Reasons for applying PLCs
- Siemens S7
- S7 SSS
- Architecture
- Code Generator
- Project 'Next'
- Discussion issues



DISTRIBUTION SYSTEMS

- Distribution centers for various sectors: care, food and fashion to automotive, parts and components, and retail.
- With solutions for: automated storage and retrieval, order picking, consolidation and sorting.
- Conveyor equipment is PLC controlled.
 High capacity sorters are FSC controlled.
 Integrated systems have their own local controllers.





BAGGAGE HANDLING SYSTEMS

- Baggage Handling systems, from regional to major hub airports.
- With solutions for, from check-in to make up and unload to reclaim. Including baggage screening, storage and sortation.
- Loose baggage conveyor transport, Tubtrax and Bagtrax.
- Conveyor equipment PLC controlled. Bagtrax has local controllers besides PLC control.





EXPRESS PARCEL SYSTEMS

- From local depot to large hubs.
- Throughputs from a few thousand parcels a day to 150.000 parcels per hour.
- Used equipment: Line sorters and loop sorters.
- FSC controlled.





FSC



Flow System Controller Used for controlling high capacity line and loop sorter systems.

• Characteristics;

- Industrial PC hardware
- Real-time operating system: QNX Neutrino
- C/C++
- CPU response time 2 msec.
- Systems are implemented by configuration.
- System layouts and functionality are restricted to building rules.

Since 15 years



Reasons for applying PLCs

Pros

- High reliability (MTBF)
- Easy and fast recovery from HW failures (MTTR)
- Robustness
- On-line monitoring and modifying
- Proven technology, widely accepted
- Programmable (FSC is not)

Cons

- Not-open systems
 - Limited communication possibilities
 - Not extendible with other applications
 - Programming languages are not standardized
- Limited memory and performance
- High hardware costs



Siemens S7

- VI engineering department is standardized on Siemens S7.
- Other PLC brands are subcontracted e.g. Allen-Bradley, Modicon, Mitsubishi, Omron
- S7-300 and S7-400. Both programmable with Step7 and largely software compatible.
- Programming language STL (IL according IEC 61131-3).

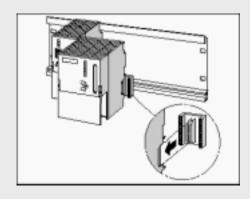


Siemens S7-300

- Modular mini PLC
- Often applied CPUs

-	workmemory	bit	Word	I Int ins
- CPU315-2 DP	128 kb	100	200	2000 ns
- CPU317-2 DP	512 kb	50	200	200 ns
- CPU319-3 PN/DP	1,4 Mb	10	20	20 ns





Int instruction

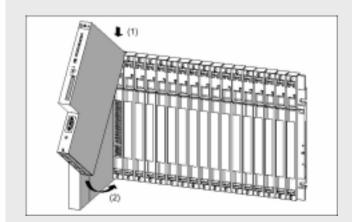


Siemens S7-400

- "Power PLC"
- Often applied CPUs
 - CPU414-2 DP
 - CPU414-3 DP (or PN/DP)
 - CPU416-2 DP (or PN/DP)

workmemory 1 Mb 2,8 Mb 5,6 Mb

bit	Word	Int instruction
45	45	45 ns
45	45	45 ns
30	30	30 ns





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PLC deployment

- PLC is applied as central controller within a sub/system.
- CPU type is chosen on required CPU resources.
- Systems are divided in subsystems, considering:
 - CPU capability
 - Logical subsystems
 - Redundancy and system availability
 - Cost price

• Distribution systems

- Focuses on minimum number of PLCs.

Baggage Handling systems

- Redundancy in system layout by repetition of autonomous subsystems for achieving higher availability.
 This leads to: use of more PLCs and smaller PLCs.
- High availability PLC solutions are seldom used.



Host (customer) st 1000 -MFC **SCADA** Ethernet **OPC Server** PLC **Profibus-DP ASi Master** Mux. **Scanners Operator Panel ASi Bus** • ASi Slaves 🚺

Controls Architecture

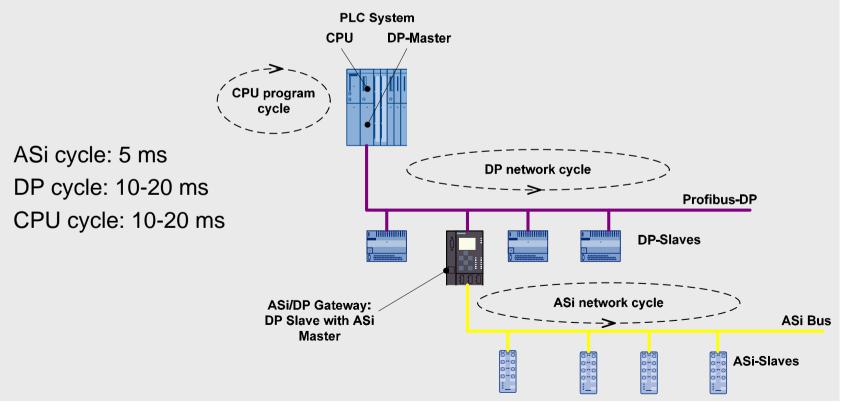
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PLC system response time

 system response time Time duration from input change to output change. typically between 50-90 ms



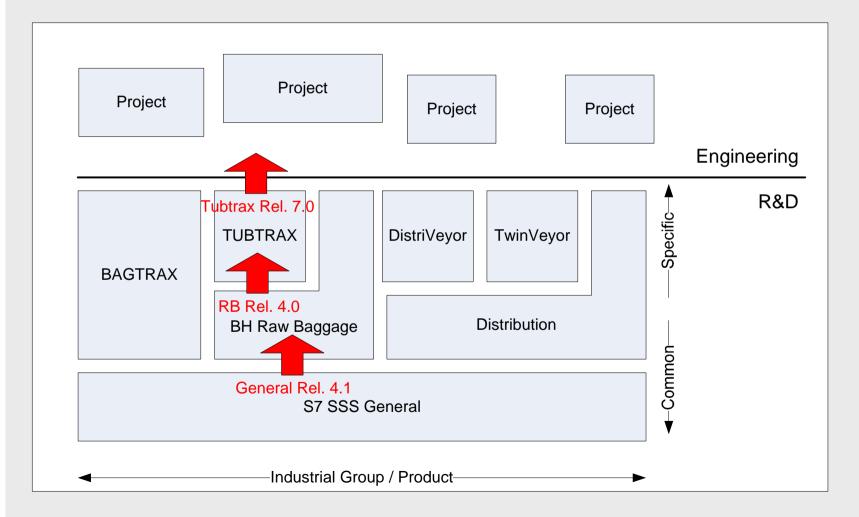


S7 SSS

- S7 Standard Software Structures Product name for the VI standard S7 software.
- Initially the S7 SSS is developed by the Engineering groups on projects by standardizing the software.
 Based upon best practices.
- Today the S7 SSS is managed and maintained by R&D.



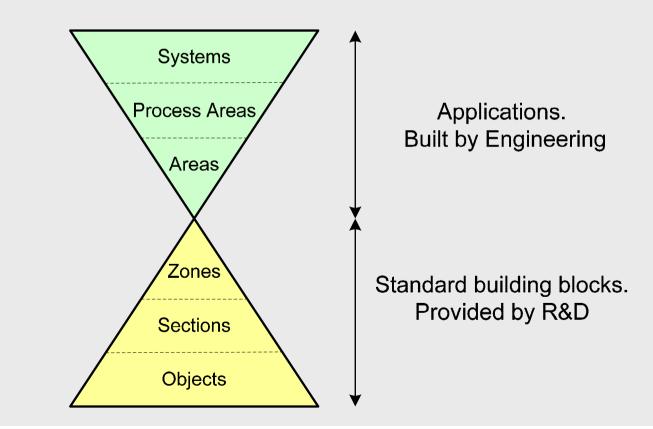
S7 Libraries





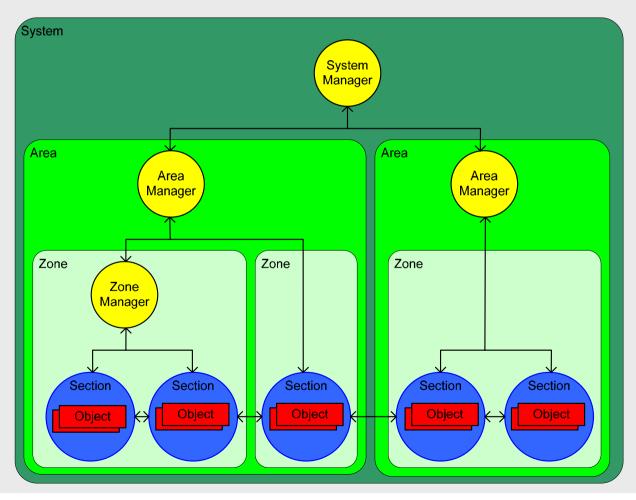
Architecture

Component Based according Sandglass model





Software Architecture

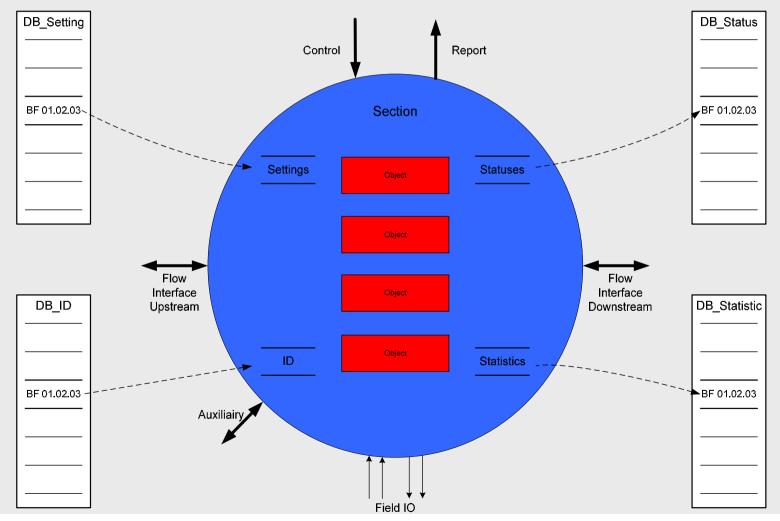


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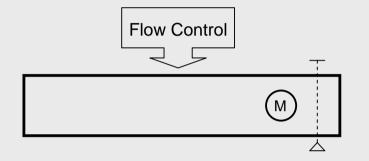
Software building block



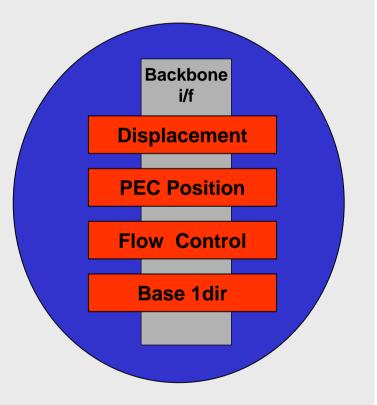
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Variants of conveyor building blocks

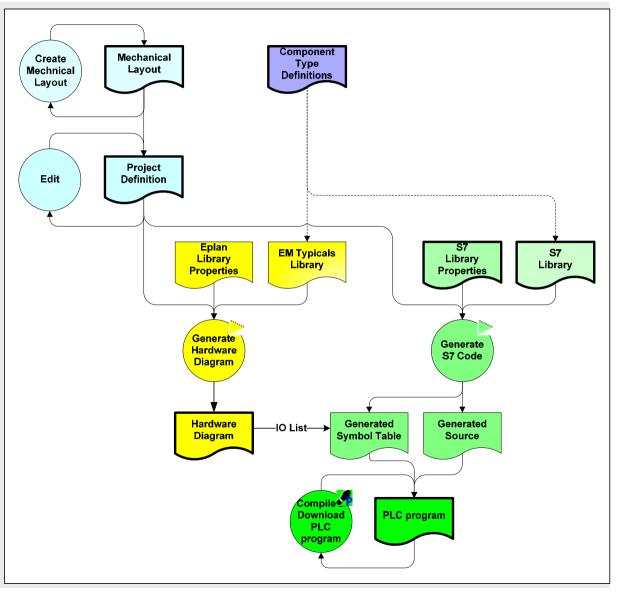


Conveyor with PEPPEC and flow control functionality.





Code Generator Suite





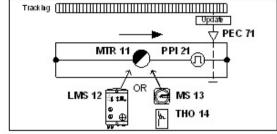
Component Туре Definitions

BF11 Owner:

General 4.0







Definition:

Tracking conveyor with PPI.

1/0 Definition:

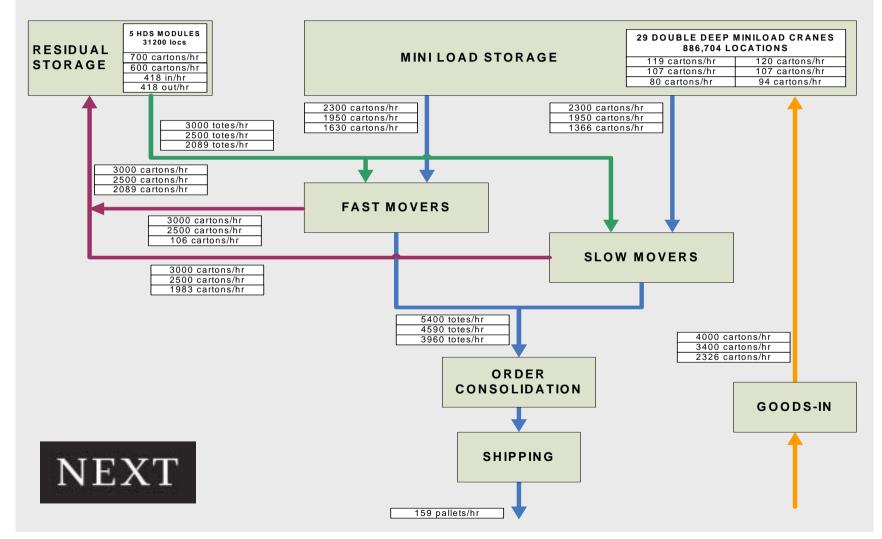
Po Demilion.		
Туре:	ID:	Comment
I_BOOL	="I_" & parent.id & "_LMS_Auto"	Mode Switch of LMS in position AUTOMATIC
I_BOOL	="I_" & parent.id & "_LMS_OK"	Healthy signal from LMS
I_BOOL	="I_" & parent.id & "_MS_On"	Maintenance Switch in position 'ON'
I_BOOL	="I_" & parent.id & "_PEC" & parent_func_a	="Photo Electric Cell" & parent_func_descr
I_BOOL	="I_" & parent.id & "_PPI" & parent_func_a	="Pulse Position Indicator" & parent_func_descr
I_BOOL	="I_" & parent.id & "_THO_OK"	No Thermal Overload
Q_BOOL	="Q_" & parent.id & "_MTR"	="Run signal to motor" & parent_func_descr

Tags:

SymbolicName LMS_12_ASI_Error	TagTypeld DS	Address 0.1
LMS_12_ASI_Not_Prent	DS	0.0
LMS_12_Not_Automatic	DS	0.2
LMS_12_Not_Healthy	DS	0.3
MS_13_Not_Automatic	DS	0.4
PEC_71_Blockage	DS	1.1
PEC_71_Missings	DS	1.2
PPI_21_Error	DS	0.6
THO_14_Th_Overload	DS	0.5



Distribution system 'Next': peakflow overview

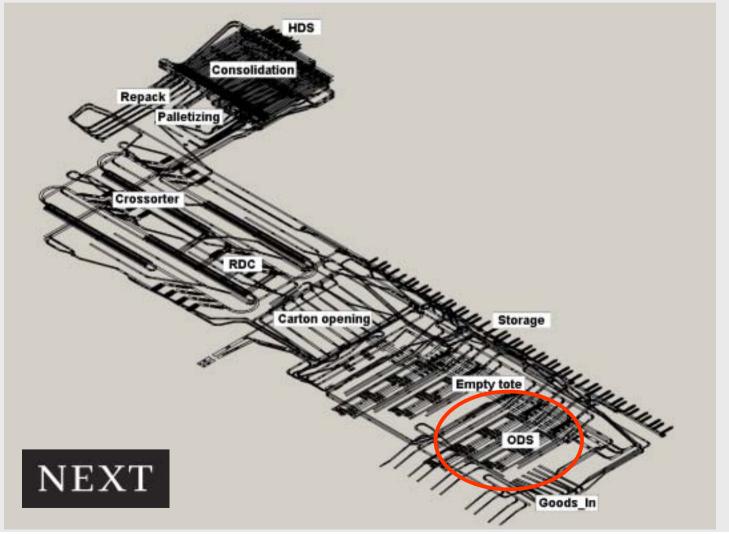


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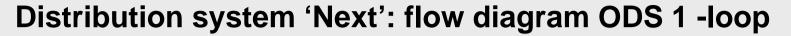
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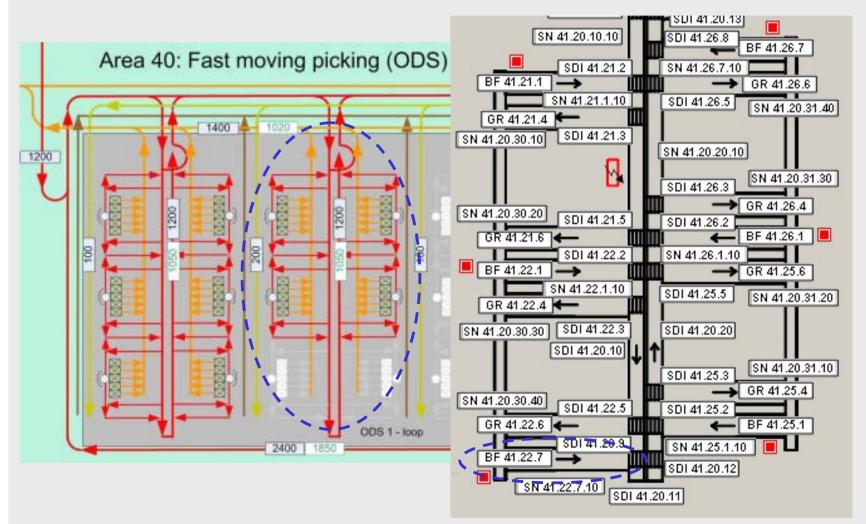


Distribution system 'Next': system layout



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Project Definition File

• BF 41.22.7 -> BF33

(fif id="downstream" isc. id="41.20.30." position="100"/> <fif id="upstream" isc_id="41.22.3." position="0"/> isc cd1_id="GR-PEC01" function="01" function_abbreviation 由 <isc cd1_id="GR-PEC01" function="01" function_abbreviation</p> isc cd1_id="GR-PEC01" function="01" function_description-Kisc activity_number="40920" asi_address="12" asi_channel="2" 🕗 <block angle1-"0" angle2-"0" bidirectional-"false" id-"0" shi <fif id="upstream" isc_id="41.25.2." position="0"/> iii 🕜 kise ed1_id="VAL01" function="01" function_description="to" (fit id="downstream" isc_id="41.22.6." position="100"/> <isc cd1_id="SDI-PEC01" function="01" function_description;</p> 🗄 🕢 kisc activity_number="41700" asi_address="12" asi_channel="2" 🗄 🕗 kise activity_number="41600" asi_address="16" asi_channel="2"..... 🗄 🕜 kisc activity_number="43200" asi_address="26" asi_channel="2" Kisc cd1_id="TZ01" es_area="" function="01" id="41.25.." integration 🖻 🥝 kisc activity_number="41600" asi_address="14" asi_channel="2" Okazati (angle1="0" angle2="0" bidirectional="Talse" id="0" shi of the state of <book angle1="0" angle2="0" bidirectional="Take" id="1" shi <fif id="downstream" isc_id="41.25.2." position="100"/> <fit id="upstream1" isc. id="41.25.1.10" position="85.337"/> <fif id="upstream0" isc_id="41.20.31." position="0"/> 🕗 kiso aux_brake="N" brake="N" od1_id="MTR01" fc_ss="N" <isc cd1_id="BF-PEC01" function="01" function_description=</p> ise cd1_id="BF-PEC01" function="01" function description=
 description="01" function function description="01" function description="01" function func E - Control -😑 🕜 kise activity number-"40920" asi laddress-"13" asi channel-"2" 🕗 <block angle1="0" angle2="0" bidirectional="Take" id="0" sha (fif id="downstream" isc_id="41.22.5." position="100"/> Image: A start of the start Kifi id="upstream" isc_id="41.25.1." position="0"/> E 42 kisc activity_number="40920" asi_address="11" asi_channel="2" Okational (1997)
Okational (1997) < All March materia and Jan. M. 1911, 20120 Consultance Physics F

IΓ	Item	Value
	id	41.22.7.
	mark_code	BF
	cd1_id	BF33
•	length	2.5
•	vila_document	094672-999-14301-EN.DWG
•	guid	9D8A87E1BED04D9D8D84D27A55CD612D
•	activity_number	41600
•	eplan_dd	41+LCC12/916A0
•	eplan_dd1	
•	eplan_dd2	
	eplan_dd3	
1	eplan_dd4	
·	eplan_dd5	
·	station_id	
	function	33
•	plo_id	41
4	100_14	12
1	and a sectors	64
4	prb_address	12
1	asi_channel	2
1	asi_address	16
1	function_description	
1	function_abbreviation	
1	The part of the second s	section
1	nominal_current	
1	motor_power	
1	es_area	19
1	thermal_overload_group	400V_GRP02
	brake	
·	aux_brake	
· ·	fc_ss	
· .	motor_isolator	
	halt time	

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4



S7 Library Property File

BF33 -> FB_BC_Track2PECNoUpd

mapping ; id="BF32" ; key="=cd1_id=&guot;BF32&guot;" ; s7_block_name="FB_BC_Track_MSpd2PEC" ; commen -20 🖻 🔣 mapping (d="BF33" ;)).ey="=cd1_id=&guot;BF33&guot;" ; s7_block_name="FB_BC_Track2PECNoUpd">commen parameter ; id="i_Control" ; type="DWORD" ; value="#s_Control" ; comment="Control-bits from level above" 2 parameter ; id="i_10_Available" ; type="BOOL" ; value="=&guot:&guot:&guot:DB_10_Available&guot:&guot:&guot parameter ; id="i_LMS_ASI_Not_Present" ; type="BOOL" ; value="=&guot;&guot;&guot;DB_Diagnose_ASI_PF& 9 parameter ; id="i_LMS_ASI_Error" ; type="BOOL" ; value="=&guot;&guot;&guot;DB_Diagnose_ASI_PF&guot;&g 9 parameter ; id="i_MTR_Automatic_Mode" ; type="BOOL" ; value="=&guot;&guot;&guot; &guot; & id_& 9 parameter ; id="i_MTR_Healthy" ; type="BOOL" ; value="=&guot;&guot;&guot; &guot; & id & &guot;1 parameter ; id="i_NOT_PEC_Pos" ; type="BOOL" ; value="=&guot;&guot;&guot; &guot; & id & &guot;! 2 Ż parameter ; id="i_NOT_PEC_Trigg" ; type="BOOL" ; value="=&guot;&guot;&guot;L_&guot; & id & &guot Q parameter ; id="i_Manual_Mode" ; type="BOOL" ; value="FALSE" ; comment="CMD; Activate manual mode" ; 2 parameter : id="i_Manual_Run" : type="BOOL" : value="FALSE" : comment="CMD: Manual run request". Ø parameter ; id="i_DB_Track" ; type="BLOCK_DB" ; s7_block_name="DB_Track_Template" ; value="=&guot;&r 2 parameter ; id="o_MTR" ; type="BOOL" ; value="=&guot;&guot;&guot;Q_&guot; & id & &guot;1_MTR& 9 parameter ; id="o_PEC_Trig_Latch" ; type="BOOL" ; value="" ; comment="Status PEC Trigger (High=Product D 9 parameter ; id="io_Auxiliary" ; type="DWORD" ; value="=&guot;&guot;&guot;DB_Aux&guot;&guot;&guot; & parameter ; id="io_FIF_Upstream" ; type="DWORD" ; value="=&guot;&guot;&guot;DB_FIF&guot;&guot;&guot;&a parameter ; id="io_FIF_Downstream" ; type="DWORD" ; value="=&guot;&guot;&guot;DB_FIF&guot;&guot;&guot parameter ; id="io_Report" ; type="DWORD" ; value="#s_Report" ; comment="Report bits to level above"



STL block call

• BF 41.22.7

Network 6: BF33 41.22.7.

id:BF33, comment:Tracking conveyor with extra PEC without update

```
CALL "FB BC Track2PECNoUpd" , "DI BF 41.22.7. BF33"
i Control
                   :=#s Control
i IO Available :="DB IO Available".BF 41 22 7
i LMS ASI Not Present:="DB Diagnose ASI PF".Gateway 12 Channel 2.Slave Not Present[16]
                     :="DB Diagnose ASI PF".Gateway 12 Channel 2.Slave Error[16]
 i LMS ASI Error
i MTR Automatic Mode :="I 41.22.7.1 MTR AUTO"
i_MTR_Healthy :="I_41.22.7.1_MTR_OK"
i_NOT_PEC_Pos :="I_41.22.7.3_PEC"
 i_NOT_PEC_Trigg :="I_41.22.7.2_PEC"
 i Manual Mode
                    :=FALSE
i Manual Run
                 :=FALSE
i DB Track
                   :="DB Track 41.22.7."
                     :="Q 41.22.7.1 MTR"
o MTR
o PEC Triq Latch
                     :=
                     :="DB_Aux".BF 41 22 7
io Auxiliary
io FIF Upstream
                     :=
io FIF Downstream
                     :="DB FIF".BF 41 22 7
io Report
                     :=#s Report
```



Issues for discussion

- It seems not possible to apply one PLC brand worldwide. The ultimate solution is having platform independent software that can be applied with Hard and SoftPLCs of (all) different suppliers.
- A promising development is the use of Object Oriented Programming for PLCs.
- An interesting trend is the use of embedded PCs for SoftPLC solutions (Programmable Automation Controllers).



Questions



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