PLC Variables Mapping

GRP Pipe Ring Stiffness Test Machine

Version 2.0 - With Direct Hardware Reading

⚠ IMPORTANT: Reading Strategy

This document defines TWO reading methods:
1. DIRECT Hardware Reading (PE Area) - For simple ON/OFF signals like Servo_Ready, Servo_Error
2. Data Block Reading (DB Area) - For calculated values, parameters, and complex data
Direct hardware reading does NOT require PLC programming - values come straight from physical inputs!

Legend

Color	Type	Description
Pink	DIRECT READ	Read directly from hardware I/O (PE/PA Area) - NO PLC programming needed!
Green	DB READ	Read from Data Block (calculated/processed values)
Orange	WRITE	Write to PLC (commands)
Blue	R/W	Read and Write (parameters, settings)

Connection Parameters

Parameter	Value	Notes
PLC IP	192.168.0.100	S7-1214C DC/DC/Rly
Rack	0	Always 0 for S7-1200
Slot	1	Always 1 for S7-1200
Port	102	S7 Protocol default

🔴 DIRECT Hardware I/O (القراءة المباشرة)

These signals are read DIRECTLY from hardware - no PLC code needed!

Snap7 Area Codes

Area	Code	Snap7 Constant	Description
PE	0x81	Areas.PE	Process Inputs (I0.0, I0.1, ...)
PA	0x82	Areas.PA	Process Outputs (Q0.0, Q0.1, ...)
MK	0x83	Areas.MK	Markers (M0.0, M0.1, ...)
DB	0x84	Areas.DB	Data Blocks (DB1, DB2, ...)

Digital Inputs - DIRECT READ (المداخل الرقمية)

```
Snap7: plc.read_area(Areas.PE, 0, byte, 1)
```

Address	Byte.Bit	Signal Name	Backend Key	Frontend	Description
I0.0	0.0	Servo_Ready	servo_ready	Indicator 🟢	Servo ready from driver (SON)
I0.1	0.1	Servo_Error	servo_error	Alarm 🔴	Servo alarm from driver (ALM)
I0.2	0.2	At_Home	at_home	Indicator 🔵	Home position limit switch
I0.3	0.3	Upper_Limit	upper_limit	Indicator	Upper limit switch
I0.4	0.4	Lower_Limit	lower_limit	Indicator	Lower limit switch
I0.5	0.5	Reserved	-	-	Reserved for future use
I0.6	0.6	E_Stop	e_stop	E-Stop 🔴	Emergency stop (NC)
I0.7	0.7	Start_Button	start_button	Indicator	Physical start button (NO)

Digital Inputs Byte 1 (I1.x)

Address	Byte.Bit	Signal Name	Backend Key	Frontend	Description
I1.0	1.0	Reserved	-	-	-
I1.1	1.1	Btn_Lock_Upper	btn_lock_upper	Physical Btn	Lock upper clamp button
I1.2	1.2	Btn_Lock_Lower	btn_lock_lower	Physical Btn	Lock lower clamp button
I1.3	1.3	Btn_Unlock	btn_unlock	Physical Btn	Unlock both clamps button
I1.4	1.4	Btn_Jog_Up	btn_jog_up	Physical Btn	Manual jog up button
I1.5	1.5	Btn_Jog_Down	btn_jog_down	Physical Btn	Manual jog down button

Digital Outputs - DIRECT WRITE (المخارج الرقمية)

```
Snap7: plc.write_area(Areas.PA, 0, byte, data)
```

Address	Byte.Bit	Signal Name	Backend Key	Connected To	Description
Q0.2	0.2	Servo_Enable	servo_enable	Servo SON	Enable servo motor
Q0.3	0.3	Alarm_Reset	alarm_reset	Servo ALM-RST	Reset servo alarm
Q0.6	0.6	Sol_Lock_Upper	sol_lock_upper	Solenoid	Upper clamp solenoid
Q0.7	0.7	Sol_Lock_Lower	sol_lock_lower	Solenoid	Lower clamp solenoid

Analog Inputs - DIRECT READ

`Snap7: plc.read_area(Areas.PE, 0, 64, 2) for IW64`

Address	Offset	Raw Range	Backend Key	Scaling	Description
%IW64	64	0-27648	load_cell_raw	0-200 kN	Load cell (0-10V)
%IW66	66	0-27648	encoder_raw	TBD	Reserved for encoder

DB1 - Test Parameters (إعدادات الاختبار)

`Snap7: plc.db_read(1, offset, size) / plc.db_write(1, offset, data)`

Offset	Variable	Type	Size	PLC Address	Backend Key	Frontend	Description
0	Pipe_Diameter	Real	4	DB1.DBD0	pipe_diameter	Input	قطر الأنبوب (mm)
4	Pipe_Length	Real	4	DB1.DBD4	pipe_length	Input	طول العينة (mm)
8	Deflection_Percent	Real	4	DB1.DBD8	deflection_percent	Input	نسبة الانحناء (%)
12	Test_Speed	Real	4	DB1.DBD12	test_speed	Display	سرعة الاختبار (mm/min)
16	Max_Stroke	Real	4	DB1.DBD16	max_stroke	Settings	أقصى مسافة (mm)
20	Max_Force	Real	4	DB1.DBD20	max_force	Settings	أقصى قوة (kN)

DB2 - Test Results (نتائج الاختبار)

`Snap7: plc.db_read(2, offset, size) - READ ONLY`

Offset	Variable	Type	Size	PLC Address	Backend Key	Frontend	Description
0	Actual_Force	Real	4	DB2.DBD0	actual_force	Live Card	القوة الحالية (kN)
4	Actual_Deflection	Real	4	DB2.DBD4	actual_deflection	Live Card	الانحناء الحالي (mm)
8	Target_Deflection	Real	4	DB2.DBD8	target_deflection	Display	الانحناء المستهدف (mm)
12	Ring_Stiffness	Real	4	DB2.DBD12	ring_stiffness	Result Card	Ring Stiffness (kN/m²)
16	Force_At_Target	Real	4	DB2.DBD16	force_at_target	Result Card	القوة عند 3%(kN)
20	SN_Class	Int	2	DB2.DBW20	sn_class	Result Card	SN Class (1250,2500..)
22	Test_Status	Int	2	DB2.DBW22	test_status	Status Badge	حالة الاختبار (0-5)
24	Test_Passed	Bool	1	DB2.DBX24.0	test_passed	Result Icon	نجاح/فشل

Test Status Values

Value	English	Arabic	Color	Description
0	IDLE	جاهز	#6B7280 Gray	Waiting for start
1	STARTING	بدء التشغيل	#3B82F6 Blue	Initializing test
2	TESTING	جاري الاختبار	#F59E0B Yellow	Moving down, applying load
3	AT TARGET	وصل الهدف	#10B981 Green	Reached target deflection
4	RETURNING	العودة	#3B82F6 Blue	Moving back to start
5	COMPLETE	اكتمل	#10B981 Green	Test finished

DB3 - Servo Control Commands (أوامر التحكم)

⚠️ **DB3 used for COMMANDS only. Status signals read from Direct I/O!**

Offset	Bit	Variable	Type	PLC Address	Backend Key	Frontend	Description
0	0	Enable	Bool	DB3.DBX0.0	cmd_enable	Toggle Btn	أمر تفعيل السيرفو
0	1	Jog_Forward	Bool	DB3.DBX0.1	cmd_jog_forward	Hold Btn	تحريك للأمام (نزول)
0	2	Jog_Backward	Bool	DB3.DBX0.2	cmd_jog_backward	Hold Btn	تحريك للخلف (صعود)
0	3	Start_Test	Bool	DB3.DBX0.3	cmd_start_test	Button	بدء الاختبار
0	4	Stop	Bool	DB3.DBX0.4	cmd_stop	E-Stop Btn	إيقاف طوارئ
0	5	Home	Bool	DB3.DBX0.5	cmd_home	Button	العودة للصفر
0	6	Alarm_Reset	Bool	DB3.DBX0.6	cmd_alarm_reset	Button	إعادة ضبط الخطأ

Real Values in DB3

Offset	Variable	Type	Size	PLC Address	Backend Key	Frontend	Unit
2	Jog_Velocity	Real	4	DB3.DBD2	jog_velocity	Slider	mm/s

🐍 Backend Code Examples

Complete PLC Connector Class

```python
import snap7
from snap7.util import get_bool, set_bool, get_real, set_real, get_int

class PLCConnector:
    def __init__(self, ip='192.168.0.100'):
        self.client = snap7.client.Client()
        self.client.connect(ip, 0, 1)


    # ========== DIRECT HARDWARE READ ==========
    def read_input_bit(self, byte, bit):
        """Read digital input directly from hardware"""
        data = self.client.read_area(snap7.client.Areas.PE, 0, byte, 1)
        return get_bool(data, 0, bit)

    def read_analog_input(self, address):
        """Read analog input (e.g., address=64 for IW64)"""
        data = self.client.read_area(snap7.client.Areas.PE, 0, address, 2)
        return get_int(data, 0)
```

Data Service with Direct Reading

```python
def get_live_data(self):
    """Get all live data for dashboard"""
    return {
        # === DIRECT FROM HARDWARE (I/O) ===
        'servo_ready': self.read_input_bit(0, 0),      # I0.0
        'servo_error': self.read_input_bit(0, 1),      # I0.1
        'at_home': self.read_input_bit(0, 2),          # I0.2
        'e_stop': self.read_input_bit(0, 6),           # I0.6
        'start_button': self.read_input_bit(0, 7),     # I0.7

        # === FROM DATA BLOCKS (Calculated) ===
        'actual_force': self.read_db_real(2, 0),       # DB2.DBD0
        'actual_deflection': self.read_db_real(2, 4),  # DB2.DBD4
        'ring_stiffness': self.read_db_real(2, 12),    # DB2.DBD12
        'test_status': self.read_db_int(2, 22),        # DB2.DBW22

        # === LOAD CELL (Direct Analog) ===
        'load_cell_raw': self.read_analog_input(64),   # IW64
    }
```

📋 Quick Reference Summary

Signal	Source	Snap7 Method	Parameters	Notes
Servo Ready	I0.0 (Direct)	read_area(PE)	byte=0, bit=0	No PLC code needed!
Servo Error	I0.1 (Direct)	read_area(PE)	byte=0, bit=1	No PLC code needed!

Signal	Source	Snap7 Method	Parameters	Notes
Load Cell Raw	IW64 (Direct)	read_area(PE)	address=64, size=2	0-27648 range
Actual Force	DB2 (Calculated)	db_read()	db=2, offset=0	Scaled in PLC
Start Test Cmd	DB3 (Command)	db_write()	db=3, offset=0, bit=3	Pulse command

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