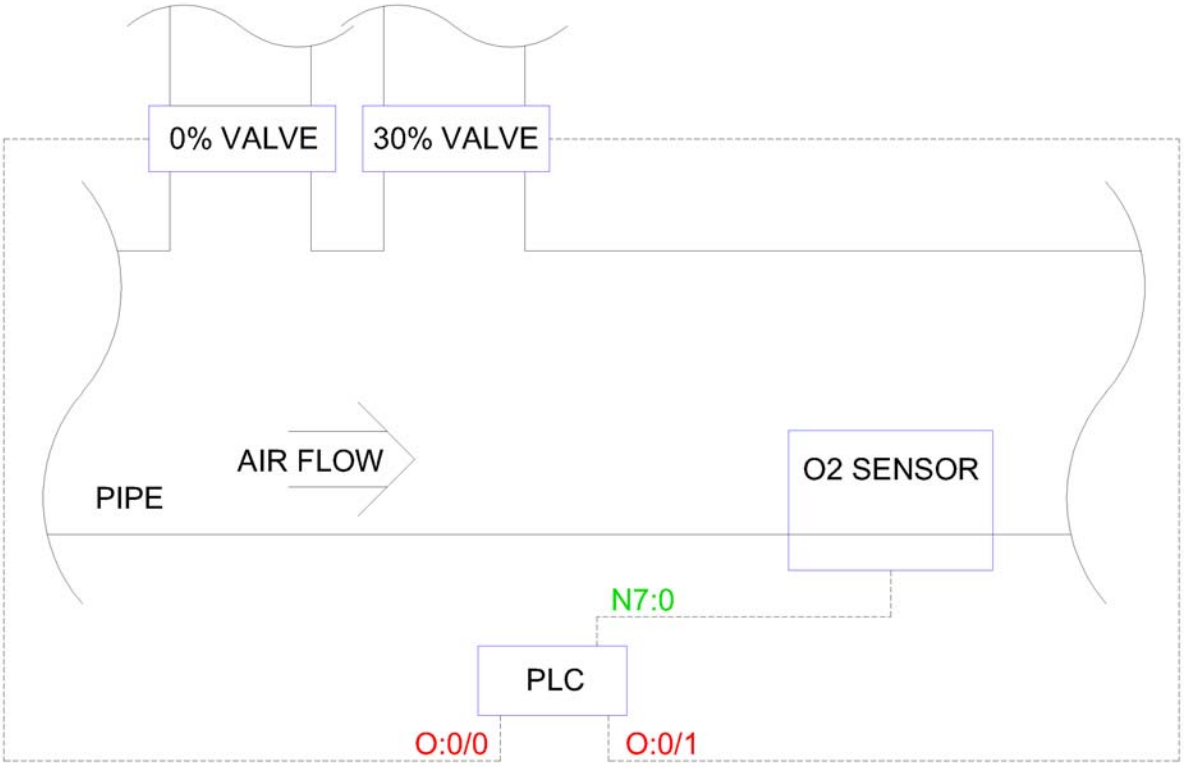
Project 7

PROCESS:



SUMMARY:

This system is at the bottom of a coal mine, and it's measuring the concentration of O2 in the air (pretty important). The O2 sensor degrades over time and requires calibration by comparing its readings to known values. Our sensor will read from 0-40%. We have calibration gases which are exactly 0% and 30% O2. This is advanced, but try it...

Our machine will have two cycles: sampling and calibration. When it's sampling, it just measures the O2 concentration of the air passing by the sensor. There's nothing special happening there.

When we go into a calibration cycle, it needs to open the 0% gas valve and sample it for 30 seconds. Next it will close the 0% and open the 30% and sample that for 30 seconds. Finally, it will use the average readings it took over those two periods and use them to "tune" its own scaling parameters according to the following calculations.

CALIBRATION CALCULATIONS:

Input Min = O2_Zero_Average

Input Max = ((O2_Maximum_ Concentration / O2_Calibration_Gas_Concentration) *
(O2_Test_Gas_Average - O2_Zero_Average)) + O2_Zero_Average

O2_Maximum_ Concentration = 40(%)
O2_Calibration_Gas_ Concentration = 30(%)
O2_Test_Gas_Average = average reading sampled during 30% gas period
O2_Zero_Average = average reading sampled during 0% gas period

IO / ASSIGNED MEMORY:

N7:0 - O2 sensor input signal
B3:0/0 - Calibrate button
O:0/0 - 0% gas valve (energize open)
O:0/1 - 30% gas valve (energize open)
N7:1 - Measured O2 concentration
N7:2 - O2 input min (for SCP instruction, default value = 0)
N7:3 - O2 input max (for SCP instruction, default value = 16383)

TEST CRITERIA:

To start, run your program on Emulate. Set N7:0 = 8192, N7:2 = 0 and N7:3 = 16383. N7:1 should be approximately equal to 20(%).

The next few steps of this test procedure are going to require some FAST ACTION on your part to get accurate results, so don't be discouraged, but it might take a little practice (or creative programming).

Next, set N7:0 = 0 and toggle B3:0/0 on and then back off immediately after. Watch your calibration cycle! You want to change N7:0 to 12288 at exactly the same moment that your calibration cycle enters its second stage (30% gas). After calibration finishes, N7:1 should be approximately 30(%). Now change N7:0 to 0. N7:1 should also be about 0. Set N7:0 to 16383. N7:1 should be about 40.

Okay, that's half of it. Here comes the hard(er) part!

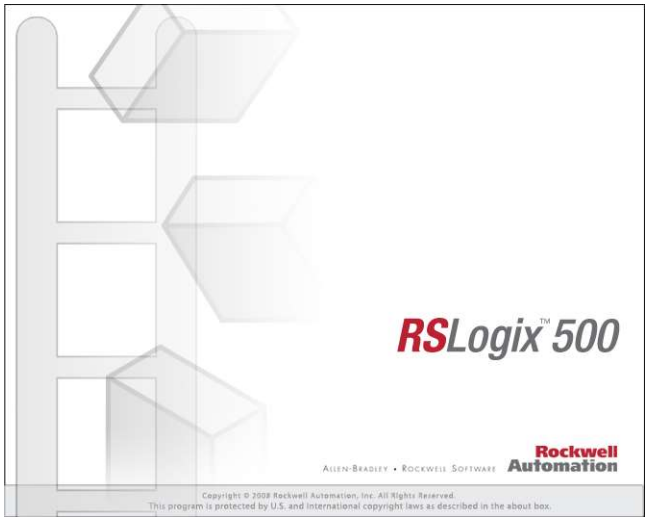
Last piece - set N7:0 = 100 and toggle B3:0/0 off and then back on immediately after. Watch your calibration cycle! You want to change N7:0 to 11000 at exactly the same moment that your calibration cycle enters its second stage (30% gas). After calibration finishes, N7:1 should be approximately 30(%). Now change N7:0 to 100. N7:1 should also be about 0. Set N7:0 to 14633. N7:1 should be about 40.

NOTES:

Do you hate me? If not, you're about to! Last section was easy. That was your vacation. This… is not. This is going to be a major, advanced hair-pulling, cat-kicking kind of experience, but if you learn it, you'll be able to do some EXCELLENT stuff with your own programs, so whatever you do or don't take from this course – make sure you walk out with a rock-solid understanding of this project. This will put you above many experienced programmers out there.

And who doesn't like to be among the bestest? ☺

RSLogix Micro Project Report



Processor Information

Processor Type: Bul.1763 MicroLogix 1100 Series B

Processor Name: PROJ7

Total Memory Used: 227 Instruction Words Used - 78 Data Table Words Used

Total Memory Left: 6429 Instruction Words Left

Program Files: 7

Data Files: 9

Program ID: 9a72

I/O Configuration

0	Bul.1763	MicroLogix 1100 Series B
1		
2		
3		
4		

Channel Configuration

CHANNEL 0 (SYSTEM) - Driver: DF1 Full Duplex
   CHANNEL 0 (SYSTEM) - Driver: DF1 Full Duplex Edit Resource/Owner Timeout: 60
   CHANNEL 0 (SYSTEM) - Driver: DF1 Full Duplex Passthru Link ID: 1
   CHANNEL 0 (SYSTEM) - Driver: DF1 Full Duplex Write Protected: No
   CHANNEL 0 (SYSTEM) - Driver: DF1 Full Duplex Comms Servicing Selection: Yes
   CHANNEL 0 (SYSTEM) - Driver: DF1 Full Duplex Message Servicing Selection: Yes
   CHANNEL 0 (SYSTEM) - Driver: DF1 Full Duplex 1st AWA Append Character: \d
   CHANNEL 0 (SYSTEM) - Driver: DF1 Full Duplex 2nd AWA Append Character: \a

   Source ID: 1 (decimal)
   Baud: 19200
   Parity: NONE
   Control Line : No Handshaking
   Error Detection: CRC
   Embedded Responses: Auto Detect
   Duplicate Packet Detect: Yes
   ACK Timeout(x20 ms): 50
   NAK Retries: 3
   ENQ Retries: 3

CHANNEL 1 (SYSTEM) - Driver: Ethernet
   CHANNEL 1 (SYSTEM) - Driver: Ethernet Edit Resource/Owner Timeout: 60
   CHANNEL 1 (SYSTEM) - Driver: Ethernet Passthru Link ID: 1
   CHANNEL 1 (SYSTEM) - Driver: Ethernet Write Protected: No
   CHANNEL 1 (SYSTEM) - Driver: Ethernet Comms Servicing Selection: Yes
   CHANNEL 1 (SYSTEM) - Driver: Ethernet Message Servicing Selection: Yes

   Hardware Address: 00:00:00:00:00:00
   IP Address: 0.0.0.0
   Subnet Mask: 0.0.0.0
   Gateway Address: 0.0.0.0
   Msg Connection Timeout (x 1mS): 15000
   Msg Reply Timeout (x mS): 3000
   Inactivity Timeout (x Min): 30
   Bootp Enable: Yes
   Dhcp Enable No
   SNMP Enable: No
   HTTP Enable: Yes
   Auto Negotiate Enable: Yes
   Port Speed Enable: 10/100 Mbps Full Duplex/Half Duplex
   Contact:
   Location:

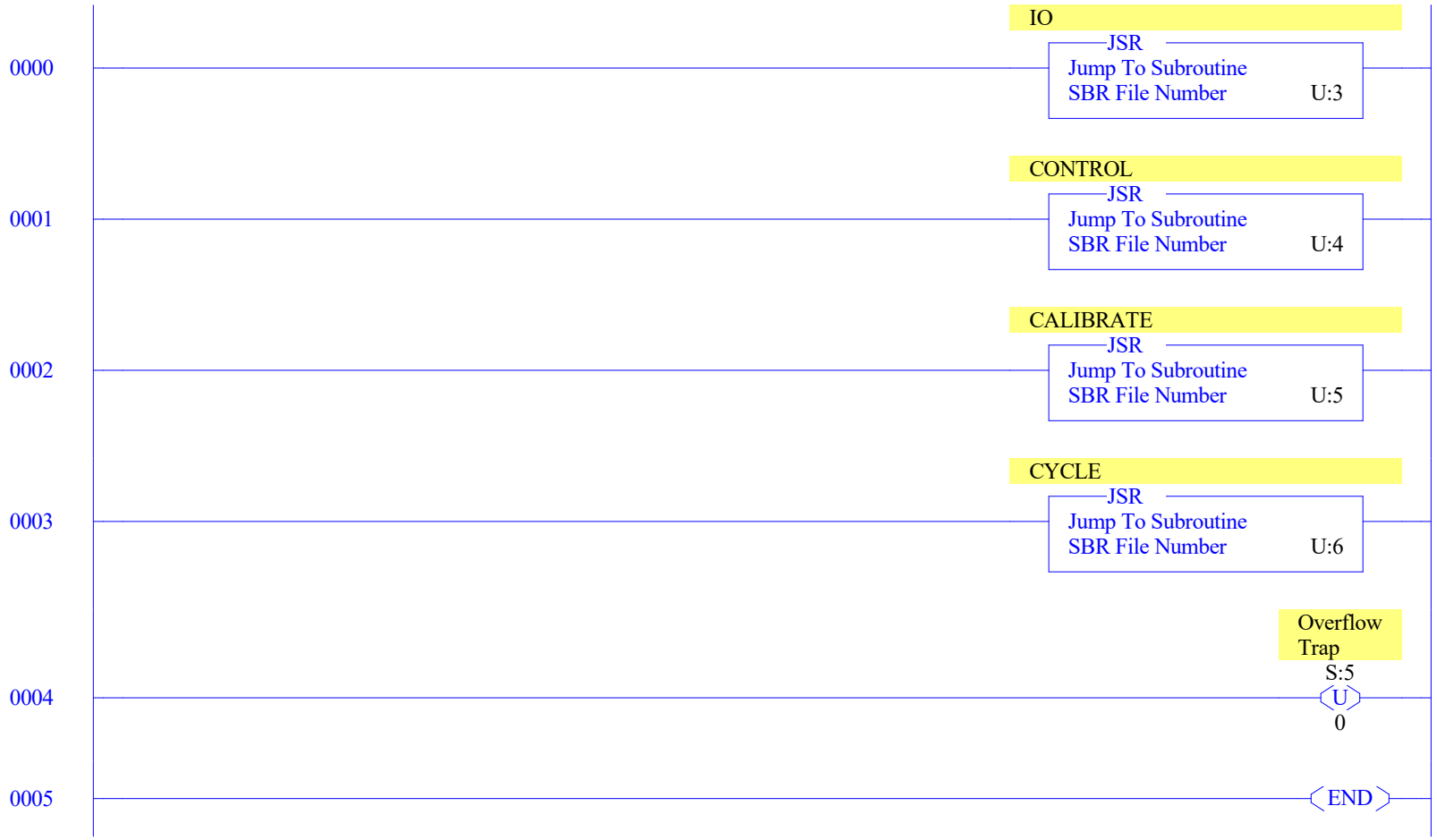
Program File List

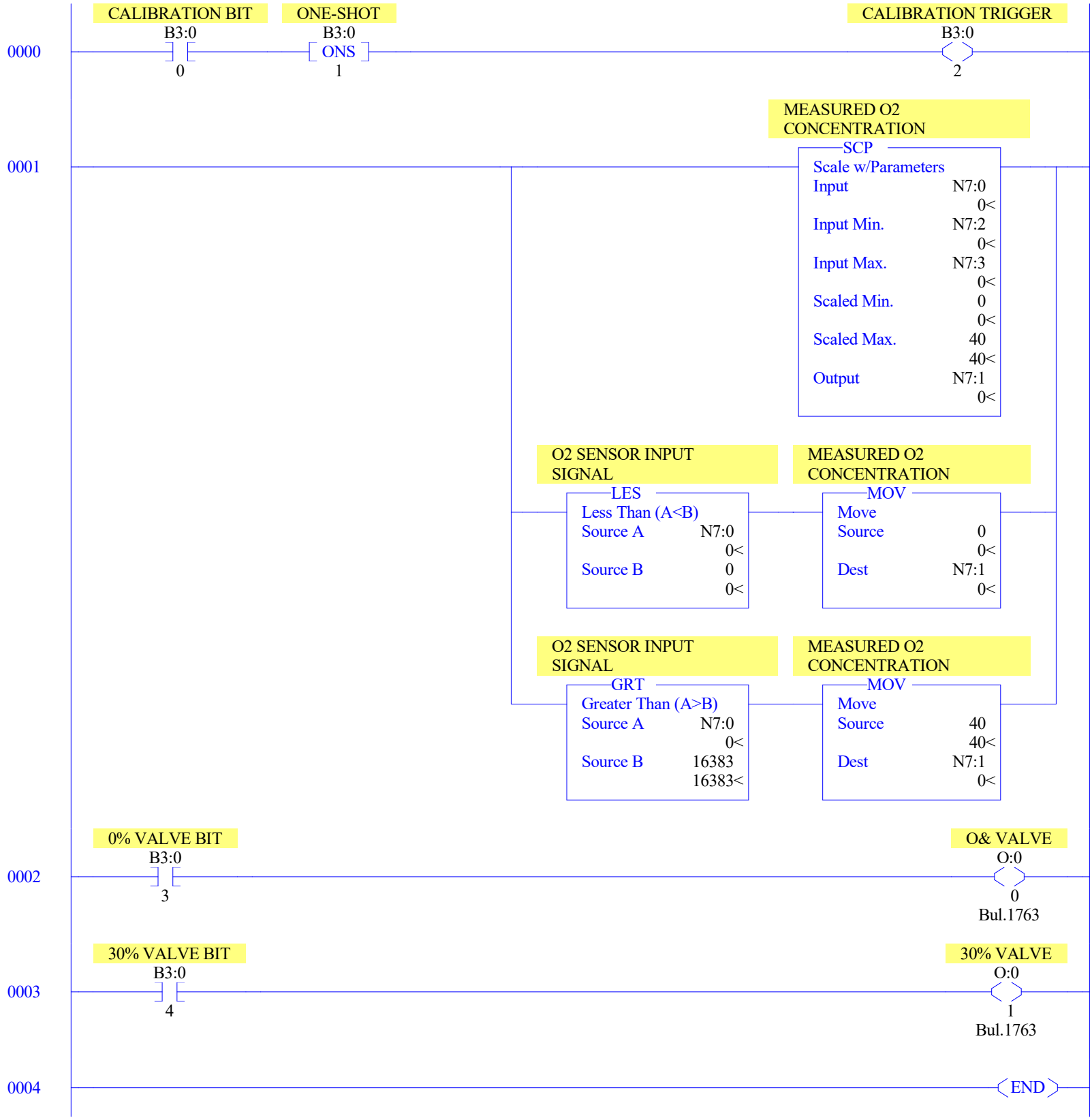
Name	Number	Type	Rungs	Debug	Bytes
[SYSTEM]	0	SYS	0	No	0
	1	SYS	0	No	0
MAIN	2	LADDER	6	No	48
IO	3	LADDER	5	No	157
CONTROL	4	LADDER	3	No	75
CALIBRATE	5	LADDER	8	No	403
CYCLE	6	LADDER	2	No	39

Data File List

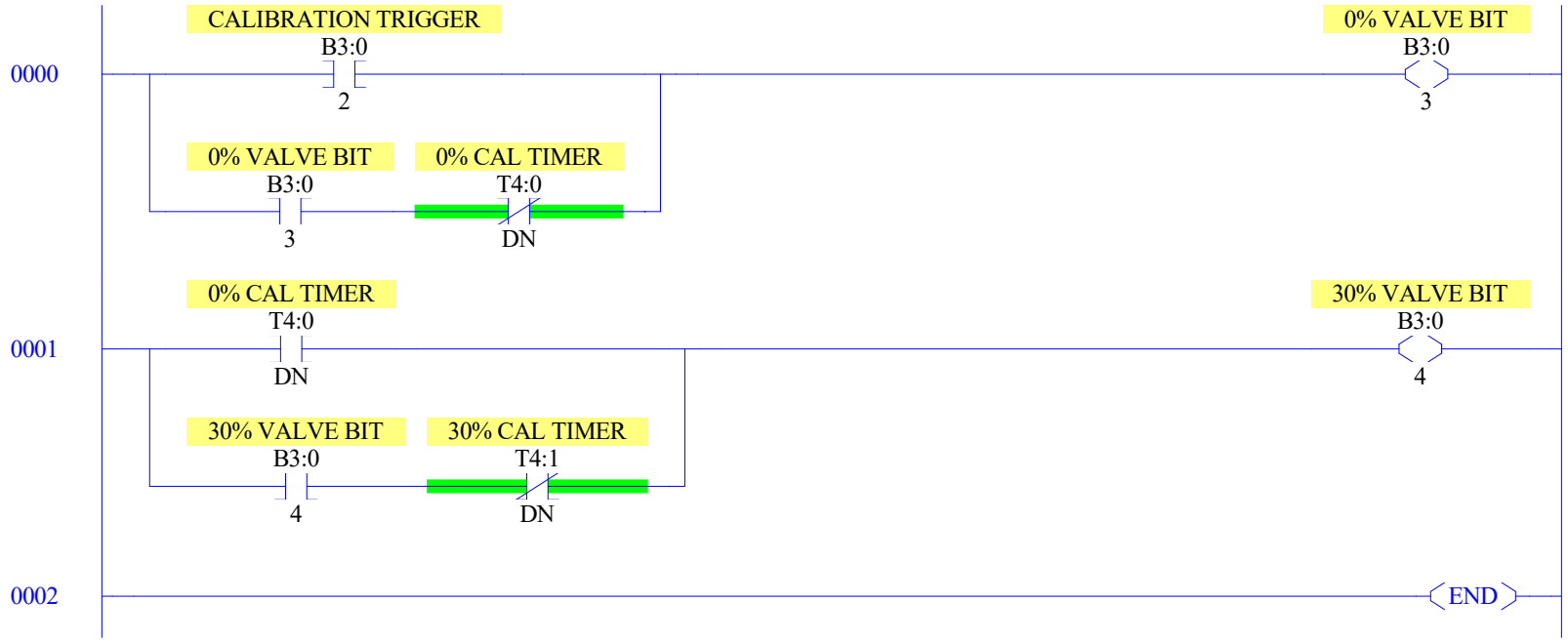
Name	Number	Type	Scope	Debug	Words	Elements	Last
OUTPUT	0	O	Global	No	12	4	O:3
INPUT	1	I	Global	No	18	6	I:5
STATUS	2	S	Global	No	0	66	S:65
BINARY	3	B	Global	No	1	1	B3:0
TIMER	4	T	Global	No	12	4	T4:3
COUNTER	5	C	Global	No	6	2	C5:1
CONTROL	6	R	Global	No	3	1	R6:0
INTEGER	7	N	Global	No	8	8	N7:7
FLOAT	8	F	Global	No	18	9	F8:8

LAD 2 - MAIN --- Total Rungs in File = 6

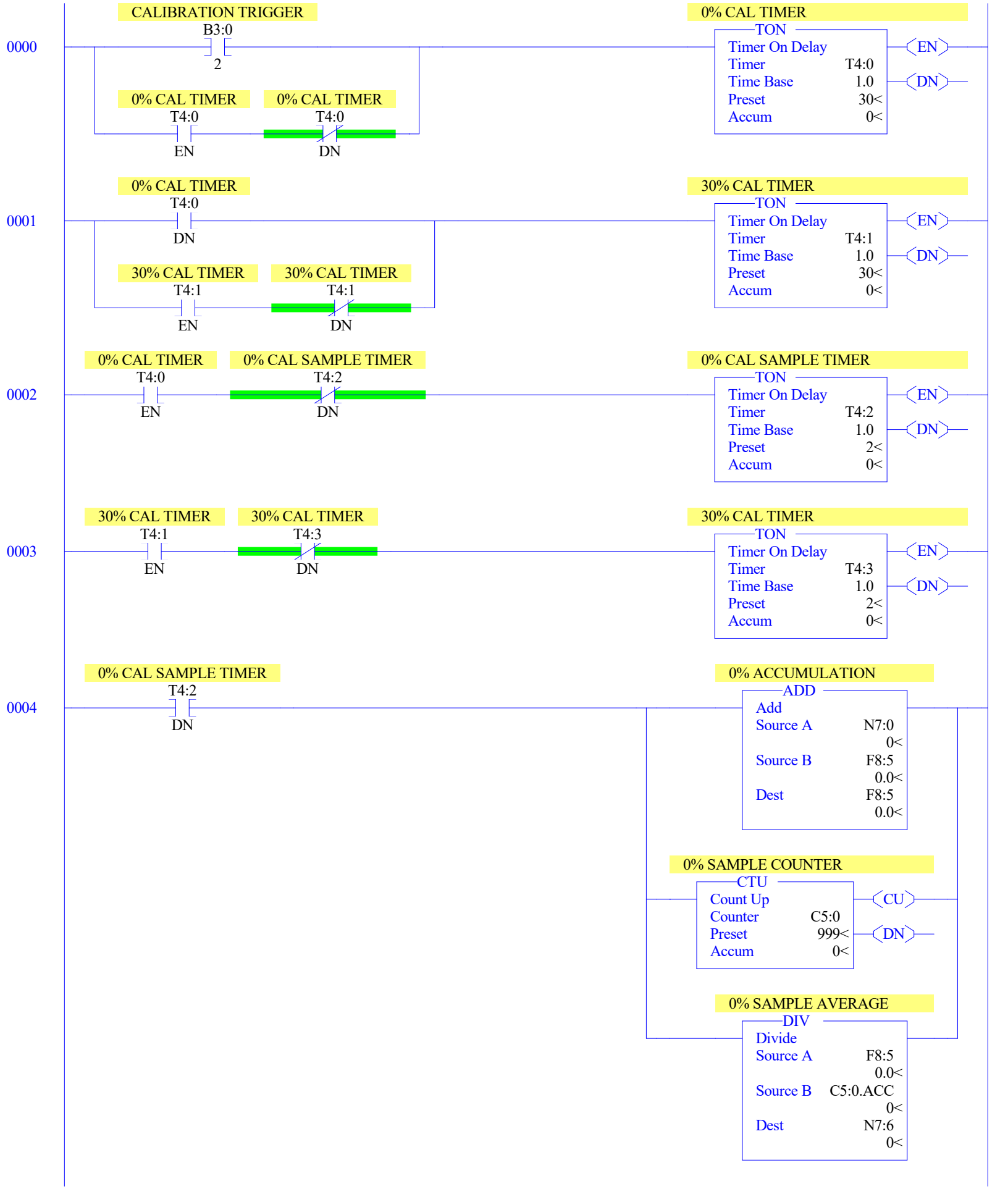



CALIBRATION BIT
B3:0
0
ONE-SHOT
B3:0
ONS
1
CALIBRATION TRIGGER
B3:0
2
0000
MEASURED O2 CONCENTRATION
SCP
Scale w/Parameters
Input N7:0 0<
Input Min. N7:2 0<
Input Max. N7:3 0<
Scaled Min. 0 0<
Scaled Max. 40 40<
Output N7:1 0<
0001
O2 SENSOR INPUT SIGNAL
LES
Less Than (A<B)
Source A N7:0 0<
Source B 0 0<
MEASURED O2 CONCENTRATION
MOV
Move
Source 0 0<
Dest N7:1 0<
O2 SENSOR INPUT SIGNAL
GRT
Greater Than (A>B)
Source A N7:0 0<
Source B 16383 16383<
MEASURED O2 CONCENTRATION
MOV
Move
Source 40 40<
Dest N7:1 0<
0% VALVE BIT
B3:0
3
O& VALVE
O:0
0
Bul.1763
0002
30% VALVE BIT
B3:0
4
30% VALVE
O:0
1
Bul.1763
0003
0004
END

LAD 4 - CONTROL --- Total Rungs in File = 3



LAD 5 - CALIBRATE --- Total Rungs in File = 8



LAD 5 - CALIBRATE --- Total Rungs in File = 8

0005

30% CAL TIMER

T4:3

DN

30% ACCUMULATION

ADD

Add

Source A N7:0 0<

Source B F8:6 0.0<

Dest F8:6 0.0<

30% SAMPLE COUNTER

CTU

Count Up

Counter C5:1

Preset 999<

Accum 0<

CU

DN

30% SAMPLE AVERAGE

DIV

Divide

Source A N7:5 0<

Source B C5:1.ACC 0<

Dest F8:8 0.0<

0006

30% CAL TIMER
T4:1
DN

MAX_CONC / CAL_CONC
DIV
Divide
Source A F8:3 40.0<
Source B F8:4 30.0<
Dest F8:0 0.0<

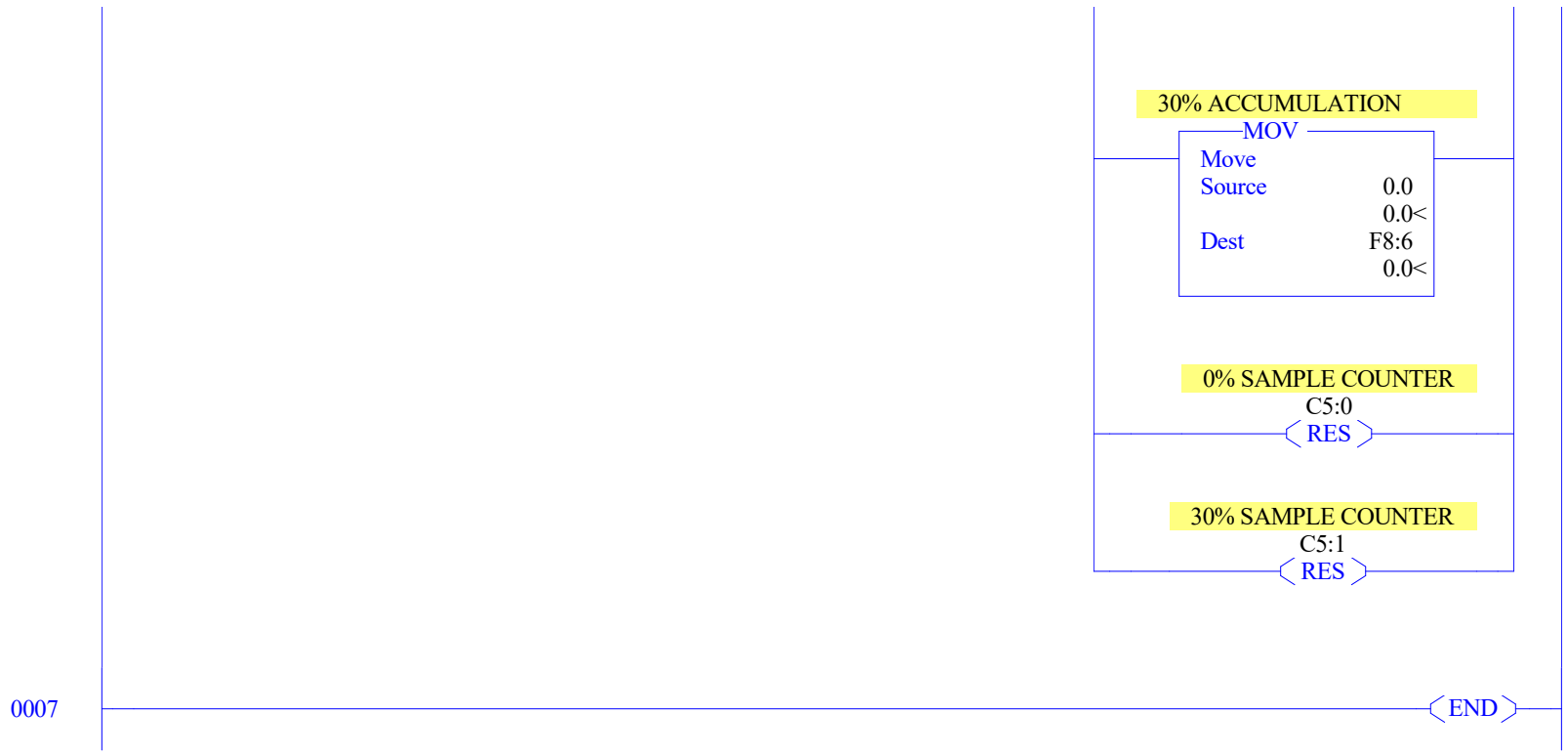
30% AVG - 0% AVG
SUB
Subtract
Source A F8:8 0.0<
Source B F8:7 0.0<
Dest F8:1 0.0<

TEMP PRODUCT
MUL
Multiply
Source A F8:0 0.0<
Source B F8:1 0.0<
Dest F8:2 0.0<

O2 INPUT MAX
ADD
Add
Source A F8:2 0.0<
Source B N7:6 0<
Dest N7:3 0<

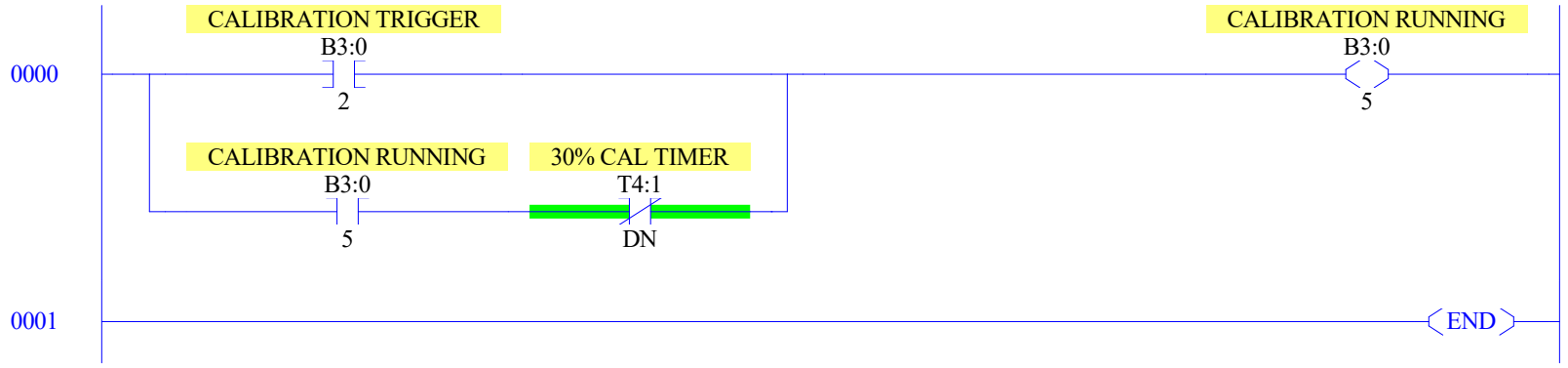
O2 INPUT MIN
MOV
Move
Source N7:6 0<
Dest N7:2 0<

0% ACCUMULATION
MOV
Move
Source 0.0 0.0<
Dest F8:5 0.0<


30% ACCUMULATION
MOV
Move
Source
0.0
0.0<
Dest
F8:6
0.0<
0% SAMPLE COUNTER
C5:0
RES
30% SAMPLE COUNTER
C5:1
RES

0007 END

LAD 6 - CYCLE --- Total Rungs in File = 2



Data File O0 (bin) -- OUTPUT

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
O:0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B
O:0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B
O:0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B
O:0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B

Data File I1 (bin) -- INPUT

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
I:0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B
I:0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B
I:0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B
I:0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B
I:0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B-Analog
I:0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Bul.1763	MicroLogix 1100 Series B-Analog

Data File S2 (hex) -- STATUS

Main

Processor Mode S:1/0 - S:1/4 = Remote Program Mode
On Power up Go To Run (Mode Behavior) S:1/12 = 0
First Pass S:1/15 = No
Free Running Clock S:4 = 0000-0000-0000-0000

Proc

OS Catalog Number S:57 = 1100
OS Series S:58 = A
OS FRS S:59 =
Processor Catalog Number S:60 =
Processor Series S:61 = A
Processor FRN S:62 =
User Program Type S:63 = 8001h
Compiler Revision Number S:64 =

Scan Times

Maximum (x10 ms) S:22 = 0
Watchdog (x10 ms) S:3 (high byte) = 10
Last 100 uSec Scan Time S:35 = 0
Scan Toggle Bit S:33/9 = 0

Math

Math Overflow Selected S:2/14 = 0
Overflow Trap S:5/0 = 0
Carry S:0/0 = 0
Overflow S:0/1 = 0
Zero Bit S:0/2 = 0
Sign Bit S:0/3 = 0
Math Register (lo word) S:13 = 0
Math Register (high word) S:14-S:13 = 0
Math Register (32 Bit) S:14-S:13 = 0

Chan 0

Processor Mode S:1/0- S:1/4 = Remote Program Mode
Node Address S:15 (low byte) = 0
Baud Rate S:15 (high byte) = ?
Channel Mode S:33/3 = 0
Comms Active S:33/4 = 0
Incoming Cmd Pending S:33/0 = 0
Msg Reply Pending S:33/1 = 0
Outgoing Msg Cmd Pending S:33/2 = 0

Debug

Suspend Code S:7 = 0
Suspend File S:8 = 0

Errors

Fault Override At Power Up S:1/8 = 0
Startup Protection Fault S:1/9 = 0
Major Error Halt S:1/13 = 0
Overflow Trap S:5/0 = 0
Control Register Error S:5/2 = 0
Major Error Executing User Fault Rtn. S:5/3 = 0
Battery Low S:5/11 = 0
Input Filter Selection Modified S:5/13 = 0
ASCII String Manipulation error S:5/15 = 0
Fault Routine S:29 = 0
Major Error S:6 = 0h
Error Description:

Protection

Deny Future Access S:1/14 = No
Data File Overwrite Protection Lost S:36/10 = False

Mem Module

Memory Module Loaded On Boot S:5/8 = 0
Password Mismatch S:5/9 = 0
Load Memory Module On Memory Error S:1/10 = 0
Load Memory Module Always S:1/11 = 0
On Power up Go To Run (Mode Behavior) S:1/12 = 0
Program Compare S:2/9 = 0
Data File Overwrite Protection Lost S:36/10 = 0

Forces

Forces Enabled S:1/5 = Yes
Forces Installed S:1/6 = No

Data File B3 (bin) -- BINARY

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	(Symbol) Description
B3:0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Data File T4 -- TIMER

Offset	EN	TT	DN	BASE	PRE	ACC	(Symbol) Description
T4:0	0	0	0	1.0 sec	30	0	0% CAL TIMER
T4:1	0	0	0	1.0 sec	30	0	30% CAL TIMER
T4:2	0	0	0	1.0 sec	2	0	0% CAL SAMPLE TIMER
T4:3	0	0	0	1.0 sec	2	0	30% CAL TIMER

Data File C5 -- COUNTER

Offset	CU	CD	DN	OV	UN	UA	PRE	ACC	(Symbol) Description
C5:0	0	0	0	0	0	0	999	0	0% SAMPLE COUNTER
C5:1	0	0	0	0	0	0	999	0	30% SAMPLE COUNTER

Data File R6 -- CONTROL

Offset	EN	EU	DN	EM	ER	UL	IN	FD	LEN	POS	(Symbol)	Description
R6:0	0	0	0	0	0	0	0	0	0	0		

Data File N7 (dec) -- INTEGER

Offset	0	1	2	3	4	5	6	7	8	9
N7:0	0	0	0	0	0	0	0	0		

Data File F8 -- FLOAT

Offset	0	1	2	3	4
F8:0	0	0	0	40	30
F8:5	0	0	0	0	

Address/Symbol Database

Address	Symbol	Scope	Description	Sym Group	Dev. Code	ABV	BLW
B3:0/0			CALIBRATION BIT				
B3:0/1			ONE-SHOT				
B3:0/2			CALIBRATION TRIGGER				
B3:0/3			0% VALVE BIT				
B3:0/4			30% VALVE BIT				
B3:0/5			CALIBRATION RUNNING				
B3:0/6			CALIBRATION INTERRUPT				
C5:0			0% SAMPLE COUNTER				
C5:1			30% SAMPLE COUNTER				
F8:0			MAX_CONC / CAL_CONC				
F8:1			30% AVG - 0% AVG				
F8:2			TEMP PRODUCT				
F8:3			MAX CONCENTRATION				
F8:4			CAL CONCENTRATION				
F8:5			0% ACCUMULATION				
F8:6			30% ACCUMULATION				
F8:7			30% SAMPLE AVERAGE				
F8:8			30% SAMPLE AVERAGE				
N7:0			O2 SENSOR INPUT SIGNAL				
N7:1			MEASURED O2 CONCENTRATION				
N7:2			O2 INPUT MIN				
N7:3			O2 INPUT MAX				
N7:4			0% ACCUMULATION				
N7:5			30% ACCUMULATION				
N7:6			0% SAMPLE AVERAGE				
N7:7			30% SAMPLE AVERAGE				
O:0/0			O& VALVE				
O:0/1			30% VALVE				
S:0			Arithmetic Flags				
S:0/0			Processor Arithmetic Carry Flag				
S:0/1			Processor Arithmetic Underflow/ Overflow Flag				
S:0/2			Processor Arithmetic Zero Flag				
S:0/3			Processor Arithmetic Sign Flag				
S:1			Processor Mode Status/ Control				
S:1/0			Processor Mode Bit 0				
S:1/1			Processor Mode Bit 1				
S:1/2			Processor Mode Bit 2				
S:1/3			Processor Mode Bit 3				
S:1/4			Processor Mode Bit 4				
S:1/5			Forces Enabled				
S:1/6			Forces Present				
S:1/7			Comms Active				
S:1/8			Fault Override at Powerup				
S:1/9			Startup Protection Fault				
S:1/10			Load Memory Module on Memory Error				
S:1/11			Load Memory Module Always				
S:1/12			Load Memory Module and RUN				
S:1/13			Major Error Halted				
S:1/14			Access Denied				
S:1/15			First Pass				
S:2/0			STI Pending				
S:2/1			STI Enabled				
S:2/2			STI Executing				
S:2/3			Index Addressing File Range				
S:2/4			Saved with Debug Single Step				
S:2/5			DH-485 Incoming Command Pending				
S:2/6			DH-485 Message Reply Pending				
S:2/7			DH-485 Outgoing Message Command Pending				
S:2/15			Comms Servicing Selection				
S:3			Current Scan Time/ Watchdog Scan Time				
S:4			Time Base				
S:5/0			Overflow Trap				
S:5/2			Control Register Error				
S:5/3			Major Err Detected Executing UserFault Routine				
S:5/4			M0-M1 Referenced on Disabled Slot				
S:5/8			Memory Module Boot				
S:5/9			Memory Module Password Mismatch				
S:5/10			STI Overflow				
S:5/11			Battery Low				
S:6			Major Error Fault Code				
S:7			Suspend Code				
S:8			Suspend File				
S:9			Active Nodes				
S:10			Active Nodes				
S:11			I/O Slot Enables				
S:12			I/O Slot Enables				
S:13			Math Register				
S:14			Math Register				
S:15			Node Address/ Baud Rate				
S:16			Debug Single Step Rung				
S:17			Debug Single Step File				
S:18			Debug Single Step Breakpoint Rung				
S:19			Debug Single Step Breakpoint File				
S:20			Debug Fault/ Powerdown Rung				

Address/Symbol Database

Address	Symbol	Scope	Description	Sym Group	Dev. Code	ABV	BLW
S:21			Debug Fault/ Powerdown File				
S:22			Maximum Observed Scan Time				
S:23			Average Scan Time				
S:24			Index Register				
S:25			I/O Interrupt Pending				
S:26			I/O Interrupt Pending				
S:27			I/O Interrupt Enabled				
S:28			I/O Interrupt Enabled				
S:29			User Fault Routine File Number				
S:30			STI Setpoint				
S:31			STI File Number				
S:32			I/O Interrupt Executing				
S:33			Extended Proc Status Control Word				
S:33/0			Incoming Command Pending				
S:33/1			Message Reply Pending				
S:33/2			Outgoing Message Command Pending				
S:33/3			Selection Status User/DF1				
S:33/4			Communicat Active				
S:33/5			Communicat Servicing Selection				
S:33/6			Message Servicing Selection Channel 0				
S:33/7			Message Servicing Selection Channel 1				
S:33/8			Interrupt Latency Control Flag				
S:33/9			Scan Toggle Flag				
S:33/10			Discrete Input Interrupt Reconfigur Flag				
S:33/11			Online Edit Status				
S:33/12			Online Edit Status				
S:33/13			Scan Time Timebase Selection				
S:33/14			DTR Control Bit				
S:33/15			DTR Force Bit				
S:34			Pass-thru Disabled				
S:34/0			Pass-Thru Disabled Flag				
S:34/1			DH+ Active Node Table Enable Flag				
S:34/2			Floating Point Math Flag Disable,Fl				
S:35			Last 1 ms Scan Time				
S:36			Extended Minor Error Bits				
S:36/8			DII Lost				
S:36/9			STI Lost				
S:36/10			Memory Module Data File Overwrite Protection				
S:37			Clock Calendar Year				
S:38			Clock Calendar Month				
S:39			Clock Calendar Day				
S:40			Clock Calendar Hours				
S:41			Clock Calendar Minutes				
S:42			Clock Calendar Seconds				
S:43			STI Interrupt Time				
S:44			I/O Event Interrupt Time				
S:45			DII Interrupt Time				
S:46			Discrete Input Interrupt- File Number				
S:47			Discrete Input Interrupt- Slot Number				
S:48			Discrete Input Interrupt- Bit Mask				
S:49			Discrete Input Interrupt- Compare Value				
S:50			Processor Catalog Number				
S:51			Discrete Input Interrupt- Return Number				
S:52			Discrete Input Interrupt- Accumulat				
S:53			Reserved/ Clock Calendar Day of the Week				
S:55			Last DII Scan Time				
S:56			Maximum Observed DII Scan Time				
S:57			Operating System Catalog Number				
S:58			Operating System Series				
S:59			Operating System FRN				
S:61			Processor Series				
S:62			Processor Revision				
S:63			User Program Type				
S:64			User Program Functional Index				
S:65			User RAM Size				
S:66			Flash EEPROM Size				
S:67			Channel 0 Active Nodes				
S:68			Channel 0 Active Nodes				
S:69			Channel 0 Active Nodes				
S:70			Channel 0 Active Nodes				
S:71			Channel 0 Active Nodes				
S:72			Channel 0 Active Nodes				
S:73			Channel 0 Active Nodes				
S:74			Channel 0 Active Nodes				
S:75			Channel 0 Active Nodes				
S:76			Channel 0 Active Nodes				
S:77			Channel 0 Active Nodes				
S:78			Channel 0 Active Nodes				
S:79			Channel 0 Active Nodes				
S:80			Channel 0 Active Nodes				
S:81			Channel 0 Active Nodes				
S:82			Channel 0 Active Nodes				
S:83			DH+ Active Nodes				
S:84			DH+ Active Nodes				

Address/Symbol Database

Address	Symbol	Scope	Description	Sym Group	Dev. Code	ABV	BLW
S:85			DH+ Active Nodes				
S:86			DH+ Active Nodes				
T4:0			0% CAL TIMER				
T4:1			30% CAL TIMER				
T4:1/DN							
T4:2			0% CAL SAMPLE TIMER				
T4:3			30% CAL TIMER				
U:2			IO				
U:3			IO				
U:4			CONTROL				
U:5			CALIBRATE				
U:6			CYCLE				

Instruction Comment Database

Address	Instruction	Description

Symbol Group Database

Group_Name	Description