CPDA-02 Processor Application Notes

AmbiLogique CPDA-02 PLC Processor Module

Contents

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1. Hardware

1.1. *Power and Grounding*

a) CPDA-02 Power

Power is supplied to the CPDA-02 from the Power/Comms module (e.g. POCO-01) via the backplane. No other power source is needed for the module itself.

Some input (control or sensor) devices may require their own power sources.

All output (indicator or actuator) devices need their own power sources.

b) CPDA-02 Grounding

All of the returns (ISWRet, IANRet, OTRRet, OANRet) are connected together, and to the 0V power on the backplane bus.

Power input to the PLC system via an AmbiLogique Power/Comms module is isolated within the POCO module. Therefore, either pole of this power supply may be connected to the CPDA-02 ground.

In the case of low voltage inputs (12, 24 or 28Vdc) it is convenient to connect the power source negative to the CPDA-02 ground, so that the output devices can be supplied from the same power source.

1.2. *Physical Input and Output*

The AmbiLogique input/output system is designed for versatility with simplicity.

There are several connection schemes shown for a variety of input and output devices shown in Appendix A.

Each of the Expansion and Special Purpose modules has a similar set of examples illustrated in its individual Data Sheet.

2. Control Diagram Hints

2.1. *Inputs to the Control Diagram*

a) Switch Inputs

Switch Input Filtering

The ISW0... inputs are designed to accept switches connected to ground, or NPN transistor inputs.

Normally, switch inputs would need de-bounce circuits to avoid the uncertainty caused by contact chatter and bounce. However the AmbiLogique ISW inputs have both hardware and software filters which avoid the need for such circuits in most cases.

The filtering on each input consists of:-

a) An RF choke and a surge arrestor diode: together these reject noise from around 100 kHz right through to the microwave region;

b) An RC low-pass filter with a time constant of 2.8 milliseconds (0.13 milliseconds in the case of counter inputs such as CPDA-02 ISW6 and ISW7);

c) The output of the filters is fed to a schmidt trigger circuit which eliminates uncertainty about the transition point of the input signal.

d) A digital filter eliminates pulses of up to 1 millisecond.

These measures provide reliable operation with most snap-action switches, such as pushbuttons and microswitches.

The reliability of the switch action can be easily tested, by creating a control diagram in which the switch input is connected to a COUNTer input (Fig. 2.1.1). The diagram can be monitored, and the switch operated a large number of times whilst watching the counter output, to see that it tracks the switch operation correctly.

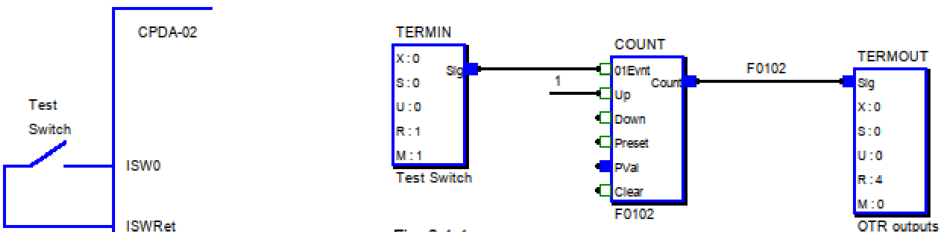


Fig. 2.1.1.
Here the switch under test is connected to ISW0.
Each time the switch is closed, the counter should advance by just ONE count.
The count is displayed on the OTRx LEDs.
Note that the R4 mask in the TERMOUT block is 0 so that it acts as an analog register.

An alternative method of displaying the counter output is to wire it to the Digital outputs (Register 4) of the CPDA processor, assuming that they are not used for anything else. The outputs can be watched by means of their indicator LEDs, which should count in a regular binary manner.

If the switch shows any tendency to bounce, but has changeover contacts, a very simple and reliable fix is obtained by connecting both contacts to separate ISWx inputs, and using them to set and reset a latch (Fig. 2.1.2). It is almost unknown for such a switch to spuriously cross over and make the alternative contact, even it is of a design which allows for considerable bounce.

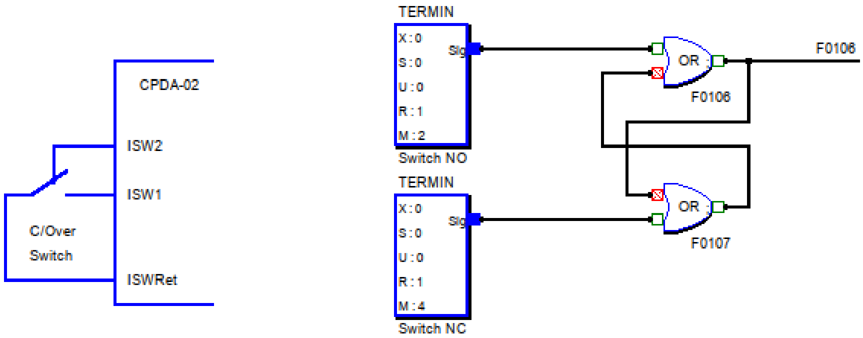


Fig. 2.1.2.
This shows the use of a latch to de-bounce a changeover switch.
Note that a latch has been constructed which is level-sensitive on both inputs, unlike the LATSR library function, which is edge-triggered on the SET input.

b) Rotary Switches

In simpler control systems where a physical control panel is implemented, it is often required to incorporate a rotary switch. These are used to select discrete process points, or different operational modes.

Normally, each position corresponds to a discrete value of a control signal: the positions might be encoded as 0..1...11 . This could then be used as the input to a set of SELCT signal selector function blocks which determine the different process points or operational modes.

Rotary switches commonly have up to 12 positions. If each position is wired to its own digital input, it will consume all of the digital inputs on a CPDA-02 Processor Module, plus half those on an EXDA-01 Expansion Module. This is clearly an expensive and inefficient use of those inputs.

By using a diode matrix, the number of inputs required for a 12-way switch can be reduced to 4, and the 4 inputs are binary encoded.

However, if there is a spare analog input and a calibrated voltage source available, there is a neat way of connecting the switch to that input, and encoding the switch position in the control diagram. Note that if a spare analog output is available, this can be used as the calibrated voltage source.

The technique is to wire a resistive ladder on to the rotary switch static contacts, and energise it from the voltage source. The voltage output at the wiper will therefore increase as the switch is rotated. The circuit is shown as Fig. 2.1.3.

The corresponding control diagram is shown as Fig. 2.1.4. In this diagram, 11 CMPGT blocks compare the analog voltage to a set of thresholds. As the switch is rotated, more of the CMPGT blocks activate, and the VOTE block produces a count of the CMPGT blocks which are active.

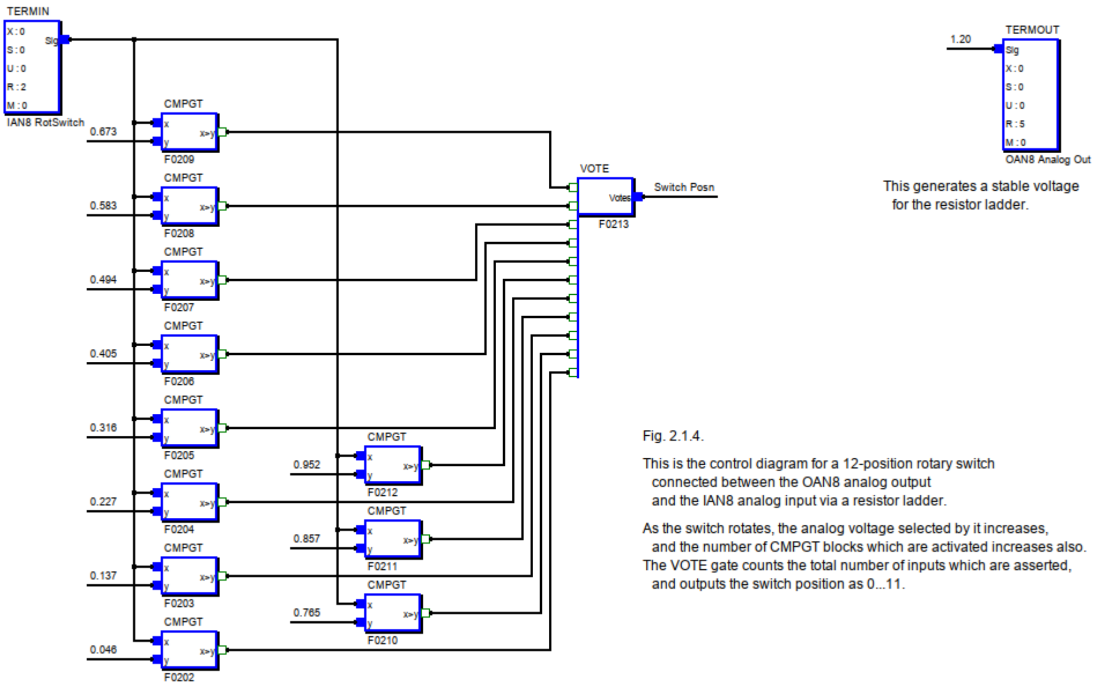


Fig. 2.1.4.

This is the control diagram for a 12-position rotary switch connected between the OAN8 analog output and the IAN8 analog input via a resistor ladder.

As the switch rotates, the analog voltage selected by it increases, and the number of CMPGT blocks which are activated increases also. The VOTE gate counts the total number of inputs which are asserted, and outputs the switch position as 0...11.

This control diagram fragment produces the exact response required: a signal which runs from 0 through 11 depending on the switch position.

The calculation of the thresholds is slightly complicated by the loading of the analog input (11.1 kohm for a CPDA-02). The values shown on the control diagram fragment are the theoretical midpoints between the switch output values, when a ladder of 11 x 100 ohm resistors is used, and is powered by a CPDA-02 analog output programmed to 1.20 V out. We can supply a spreadsheet into which you can plug your own conditions to compute the optimum theoretical thresholds for the correct operation of this diagram.

c) Temperature Input Devices

LM235 is a linear **voltage** temperature sensor. It is inexpensive and simple to use.

Because it is a **voltage** device, it is excellent for temperature sensing close to the PLC module.

The circuit below (Fig. 2.1.5) shows how the LM235 can be connected to an IANxx input of a CPDA-02 or EXDA-01. The circuit gives an excitation current of about 3 mA to the LM235, and extends the analog input range of the PLC by means of the 27 Kohm series resistor. The 15V supply is available from the expansion connector of a BPEXxx backplane. The circuit can be adapted for other supply voltages by adjusting the value of the (3.9 Kohm) feed resistor.

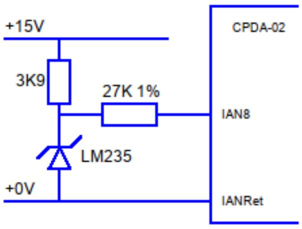


Fig. 2.1.5.
Connection diagram for LM235 temperature sensor.

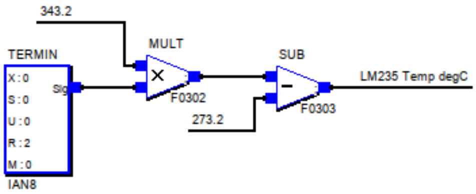


Fig. 2.1.6.
Control diagram to convert LM235 input to degrees C.

The input scaling factor is (27 + 11.1) / 11.1 = 3.432. (11.1Kohm is the input resistance of the PLC analog input). The LM235 voltage is scaled such that 1 volt = 100 °K.

So if we MULTiply the TERMIN signal by 343.2 we get temperature in °K; SUBtract 273.2 to give us °C. The maximum temperature is (343.2 – 273.2) = 70°C. The control diagram for this is Fig. 2.1.6.

The LM235 is capable of measuring temperatures up to 125 °C (398 °K). To make this range available, at slightly less resolution, make the series resistor 33.0 Kohm. The effective input range is now 3.973 V, corresponding to 397.3 °K. Substitute the 397.3 as the input to the MULT function block, and now we have the full range of the LM235 available.

Note that, although the guaranteed input range of the PLC is 1.00V, there is between 5 and 10% over-range which will be accurately converted and transmitted to the control diagram via the TERMIN.

AD590 is a linear **current** temperature sensor. Again, simple to use, but more expensive than the LM235. A small ceramic package is available which enables the sensor to be mounted in confined spaces.

Because AD590 is a **current** device, it is better for sensing temperature some distance from the PLC.

The circuit below (Fig. 2.1.7) shows how the AD590 can be interfaced to the IANxx input of a CPDA-02 or EXDA-01. The supply voltage is not critical, however care must be taken to ensure that the voltage across the AD590 remains within its specification of 4 to 30V.

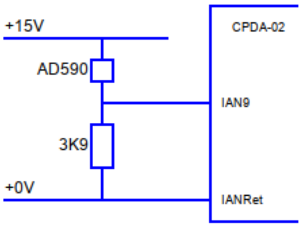


Fig. 2.1.7.
Connection diagram for AD590 temperature sensor.

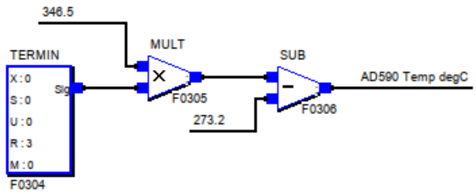


Fig. 2.1.8.
Control diagram to convert LM235 input to degrees C.

The PLC input is shunted by 3.9 Kohm to give an effective resistance of 2.886 Kohm. When the full scale of 1.00V is developed across this, the sensor current is 346.5 µA, representing 346.5 °K or 73.3 °C

So if we MULTiply the TERMIN signal by 346.5 we get temperature in °K; SUBtract 273.2 to give us °C. This version of the control diagram is shown in Fig. 2.1.8.

The AD590 is capable of measuring temperatures up to 150 °C (423 °K). To make this range available, at slightly less resolution, make the shunt resistor 3.0 Kohm. The effective input resistance is now 2.362 Kohm and the full scale current is 423.4 µA, corresponding to the same value temperature Kelvin. Substitute the 423.4 as the input to the MULT function block, and now we have the full range of the AD590 available.

d) Counter Inputs

Digital inputs ISW6 and ISW7 have medium speed counters attached to them.

Because of this, the low-pass filters on these inputs are set to a higher break frequency than the other inputs.

Each input has an up-counter attached to it (Count6, Count7). This will operate regardless of any control diagram activity apart from the Counter Control Register.

Count6 is available at SS0:R7 (Subslot 0, Register 7); Count7 at SS0:R8.

The two inputs work together to supply a third counter, CountQ. This is an up-down counter which will keep track of a quadrature encoder connected to these two inputs.

The value of CountQ is on SS0:R9.

The counters can be controlled via masked bits in the Counter Control Register, SS0:R10 as:-

> Count6 is reset by bit 0 (M1) or held, i.e. discontinues counting input edges by asserting bit 1 (M2).
>
> Count7 is reset by bit 2 (M4) or held by bit 3 (M8).

The quadrature counter CountQ has no hold facility. Instead it has two reset mechanisms:

> R10:M16 is an unconditional reset and will force the CountQ output to zero immediately it is asserted. The bit is automatically cleared after the reset has occurred.

R10:M32 is a conditional or synchronous reset: once asserted, the bit remains so until ISW6 and ISW7 are both 0. At this point the counter output is zeroed and the reset bit is negated automatically.

e) Analog Input Scaling

IANx inputs to CPDA-02 and EXDA-01 modules are scaled 0 – 1.0V with an input resistance of 11.1Kohm (± 0.1%)

The simplest instance of scaling these inputs is to add a 100Kohm resistor in series: this scales the input to 0 – 10.0V . In this case, the signal output by the TERMIN function block attached to the scaled input needs to be multiplied by 111.1 / 11.1 = 10.0 in order to read the voltage applied to the input end of the scaling resistor.

Other useful scale values are as follows:-

Resistor KΩ	Scale		Resistor KΩ	Scale
0	1.000		150	14.51
12	2.081		160	15.41
22	2.982		220	20.82
33	3.973		270	25.32
43	4.874		330	30.73
47	5.234		390	36.14
56	6.045		430	39.74
68	7.126		560	51.45
100	10.01		820	74.87
120	11.81		1.10 MΩ	100.1

Ideally the scaling resistor should be connected as close to the input terminal as possible. This usually means that one of the resistor end-wires is clamped into the terminal, and the other end has a panel wire attached to it.

This arrangement can be fragile if not carried out in an optimal way. AmbiLogique practice is as follows:

- Use ceramic-cored metal film axial resistors: these are usually supplied in 1% tolerance. They are also reasonably robust.
- Measure the length of the lead wire and divide by 3. For example, a 25 mm wire is roughly 3 sections of 8 mm.
- Fit one length (8 mm in the above example) of 1.6 mm bore sleeving over the lead wire which is going to connect into the terminal. If you use heat-shrink sleeving, leave it unshrunk so that it remains flexible. Preferably use PVC, PTFE or nitrile rubber sleeving.

- Push the sleeving up against the resistor body, and bend the bare end of the lead wire double.
- Fit a suitable ferrule over the bare doubled wire, and crimp it in place.
- Fit the cable ident on to the panel wire, followed by a 25 mm length of nitrile rubber sleeving. Do not use heat-shrink: it will produce a stress point due to its stiffness.
- Strip the panel wire end and wrap it round the resistor lead to make a spiral joint: solder the joint and trim off excess lead wire.
- Push the nitrile sleeve up to the resistor body (using lubricant if necessary) so as to cover the soldered joint and any bare resistor lead.
- Push the cable idents up to the end of the nitrile sleeve.
- Fit the ferrule into the PLC module terminal and secure.
- When both analog inputs have been wired in this way, fit a cable tie round the two nitrile sleeves and the IANRet wire, and secure.

This will form a sturdy assembly which will withstand the stresses imposed by technicians plugging and unplugging the connector.

f) Computer Input via Serial Port

Current model CPDA-02's carry 50 Computer Interface Registers in Subslot 0, with register numbers R11 through R60.

These can be written to or read from via the RS-232 port on the POCO-01 Power/Comms module using the ARTPC protocol at 115,200 bps. Port settings are 115200, N, 8, 1.

These registers can be attached to either TERMIN or TERMOUT function blocks so as to be read into or output from the control diagram.

The registers all have identical properties, and can be used to transmit analog values or arrays of digital bits.

However, in service any register can only transmit data in one direction, so it is important to make a design decision about which registers are commands and data inputs for the PLC and which will be used to recieve status and data output from the PLC.

g) Regular Constants

Regular constants are numerical values which are hard-wired into the control diagram. They are formed by means of a wire with an open input end, and with a label which the compiler can interpret as a number, including scientific 'e' notation.

If a constant needs to be changed, it is edited on the control diagram by editing the wire properties. The relevant diagram sheet then needs to be wire-checked, and the entire diagram re-compiled, then uploaded ito the PLC.

For this reason, we recommend that only very permanent values be incorporated as constants. If there is a significant probability that the value will need to be changed in the field, then we suggest the use of a K-Factor.

h) K-Factors

K-Factors are an extremely valuable addition to the CPDA-02 toolset. These factors are used to set semi-permanent constants in the control diagram, which can be edited and tuned without stopping the process being controlled.

Because of this, K-Factors are much more efficient in commissioning and maintenance operations than control diagram constants.

K-Factors are defined in a script file named “KF****.txt” where the stars represent any textual characters. The file name can be any that conforms to the file name specifications of the operating system, so long as it starts with the upper case “KF” and carries the “.txt” extension.

Each K-Factor is connected into the control diagram via a TERMIN function block with:-

- a boX address of 0,
- a sUbslot address of 6,
- and a Register address corresponding to the serial number of the K-Factor.

Just as with any other instance of a TERMIN, the signal can be masked to filter specific bits in or out of the signal.

K-Factors are more fully described in the AmbiL_PLC help system. You can access this without downloading the software here.

2.2. *Outputs from the Control Diagram*

Control diagram outputs are implemented via TERMOUT function blocks.

Data sheets for the various modules provide the Subslot, Register and Mask values for all of the output devices available on that module.

a) Hardware Output Devices

Most PLC outputs are digital, and in the AmbiLogique system are mainly NPN transistor outputs rated at up to 2A.

These outputs are designed for supply voltages up to 36V. They are protected against flyback energy from inductive loads by means of VDR's. These devices, in conjunction with the output transistors, limit flyback voltage to less than 90V. If more protection is required, consider using a SASN-02 suppression module.

Some modules such as the EXDA-4201 incorporate relay outputs: see the relevant data sheet for contact ratings.

Analog outputs are usually 0 to 10V: these are controlled by feeding the voltage value into the relevant TERMOUT block. The EXDA-4201 provides 0 to 20mA outputs which are controlled by feeding the mA value into their relevant TERMOUT block.

The 10V outputs from the CPDA-02 and EXDA-02 incorporate a 100 ohm current-limiting resistor in series: this needs to be taken into consideration when using them with loads with a significantly low resistance.

b) Counter Control

The CPDA-02 and EXDA-02 incorporate counters attached to some of the digital inputs.

ISW6 and ISW7 have a digital up-counter attached to each. This counter increments on each 0-to-1 transition of its input. These are called the C6 and C7 counters respectively.

The two inputs are attached to a quadrature counter which will follow a standard quadrature encoder and count up or down depending on the direction of rotation of the encoder. This is called the CQ counter.

The counters are controlled via bits in a register located at Subslot 0, R9 as follows:-

Bit 0 (mask 1) forces C6 to zero;

Bit 1 (mask 2) locks C6 and holds its value;

Bit 2 (mask 4) forces C7 to zero;

Bit 3 (mask 8) locks C7 and holds its value;

Bit 4 (mask 16) forces CQ to zero immediately;

Bit 5 (mask 32) forces CQ to zero when both inputs are negated, i.e. off.

These counter-enabled inputs have much higher cutoff frequencies than the other switch/NPN inputs. However, the input frequency needs to be less than 1.3 kHz for reliable operation.

c) Output to Computer via Serial Port

This is carried out via TERMOUT blocks which address the Computer Interface (CIF) registers in Subslot 0, R11 through R60.

Single bits or groups of bits can be output using the TERMOUT masks in the normal way. This limits registers to 12 bits. Alternatively bits can be assembled outside the TERMOUT by using BITASS, BITOR and MULT blocks, and then sent to a TERMOUT with a mask value of 0 which disables the masking function within the TERMOUT.

2.3. *Communicating with a Computer*

AmbiLogique PC's are designed with co-operation with a process control computer in mind. The serial communications port is always active and can be used to send commands and data to the PLC, and acquire status and data from the PLC.

Serial communications activity does not significantly affect the performance of the PLC.

a) Serial Communications Connection

The serial connection is made via RS-232 at 115200, N, 8, 1. For the CPDA-02 this is a non-network connection with a Box address of 0. There is no bus echo on this port.

Communication is carried out via the ARTPC master-slave protocol where the computer is the Master and the PLC is the Slave.

b) The ARTPC Protocol

ARTPC is a master-slave protocol which can be used in single-drop or multi-drop situations. It offers excellent noise immunity, extremely low dropout frequency, and fast error recovery.

The protocol uses all ASCII printable characters, and can be displayed or printed for investigative purposes.

This has been in use in mission-critical applications such as marine steering and helicopter engine control since 2005.

The ARTPC protocol definition document is available on the AmbiLogique website

https://www.ambilogique.com/ARTPC_DS_2_1.pdf

If the data sheet has been updated such that the above link no longer works, the correct link will be found on the "Interesting" tab on the Ambilogique website.

c) Interface Registers

The Computer Interface (CIF) registers are in Subslot 0, R11 through R60.

The computer accesses these by sending the PLC either a Block Request (data from PLC to computer) or a Block Command (data from computer to PLC).

These packets address either a single CIF register or a contiguous block of registers.

The PLC responds to a Block Request with a Block Assert which carries a re-statement of the register(s) addressed, and their contents.

The PLC responds to a Block Command with a Block Acknowledge, signalling either success, or a fault code.

Details of these transactions are set out in the ARTPC document referenced above.

2.4. *Control Diagram Hints and Tips*

a) Sequencers

Sequencers are an extremely important technique in control systems.

An elementary sequencer is shown in the example Sequence_washer. This acts as a simple motorised switch, that is one which steps from one state to the next, eventually returning to its idle condition.

The AmbiLogique sequencer system is capable of much greater sophistication. Any step in the sequence can be vectored to any other, making it easy to cater for emergency conditions, or fail-to-function exceptions.

In the examples that follow, the core function block is a Sample-Hold, which offers a slightly simpler implementation than a Select block with feedback (such as shown in the Sequence_washer example, and in Fig 2.4.1).

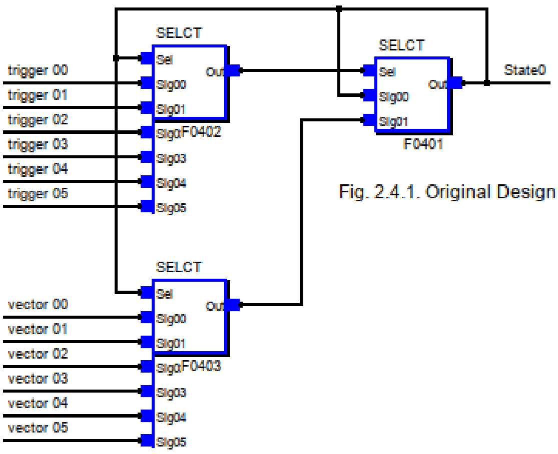


Fig. 2.4.1. Original Design

Our Sample-Hold example (Fig. 2.4.2) is shown on Sheet 4 of the control diagram examples at the end of this document.

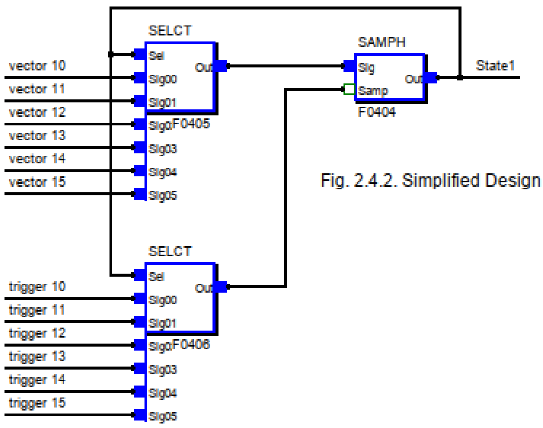


Fig. 2.4.2. Simplified Design

Emergency Stop

It is a common requirement for sequencers which control industrial machinery to respond immediately to an Emergency Stop. The foregoing sequencers are not readily amenable to this, so an alternative implementation is shown in Fig. 2.4.3. Here a Count block is used as the sample-hold device, but its Clear input overrides all other inputs and forces the sequence state to 0 = Idle.

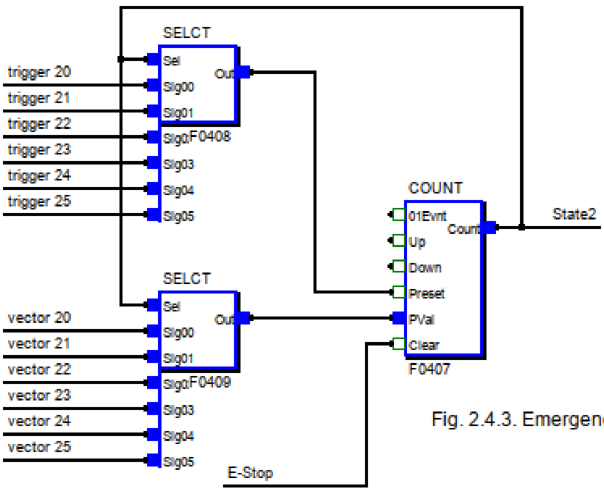


Fig. 2.4.3. Emergency Stop Design

Note that the unconnected pins are removed from the device by the AmbiLogique compiler before uploading to the PLC, so unlike a hardware device, they have no opportunity to interfere with the operation of the system.

Larger Sequencers

Fig. 2.4.4 shows how SELCT selector blocks can be cascaded to build larger sequencers. The example shown divides the steps into decades, which is a very convenient if slightly inefficient division. The SELCT function can be expanded to 14 signal inputs, but this makes the diagram awkward to name and understand.

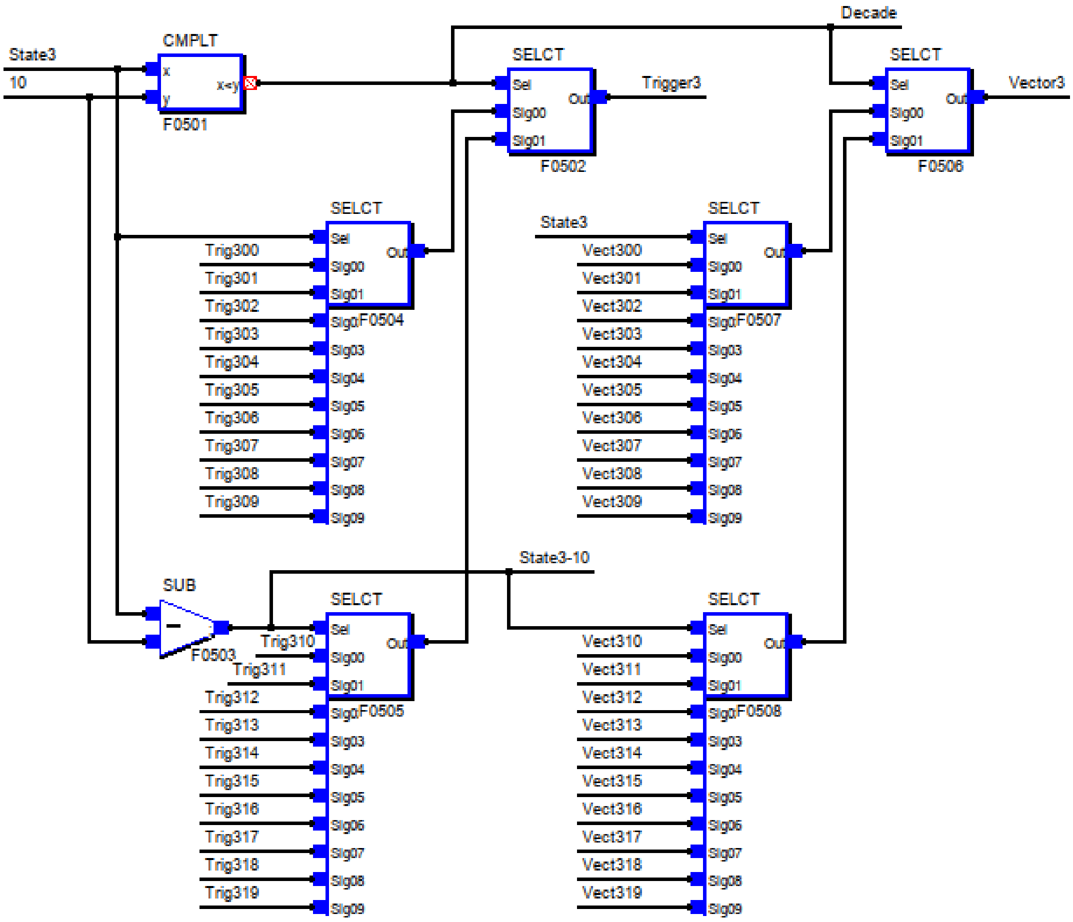
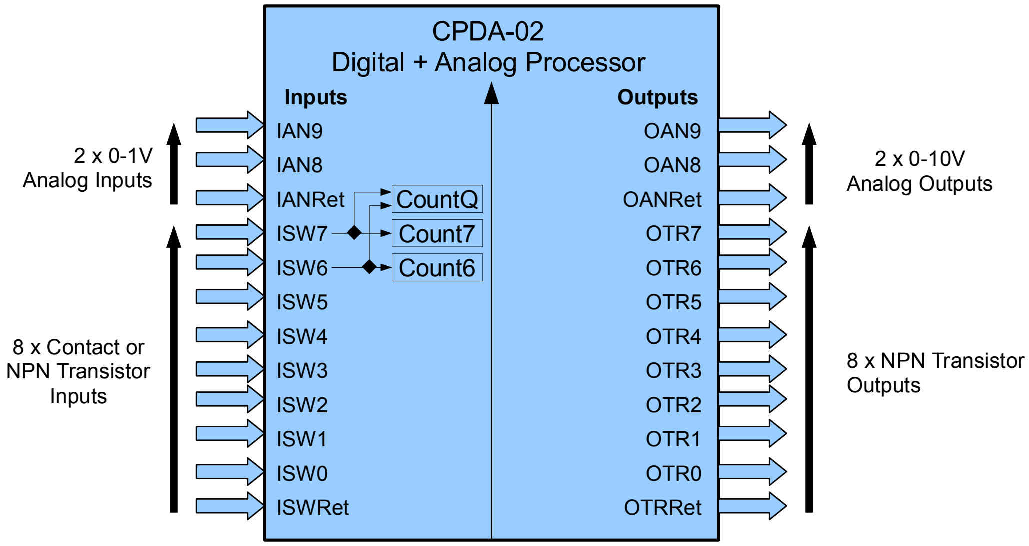


Fig. 2.4.4. Large Sequencer

3. Appendix A: Input/Output Connection Examples



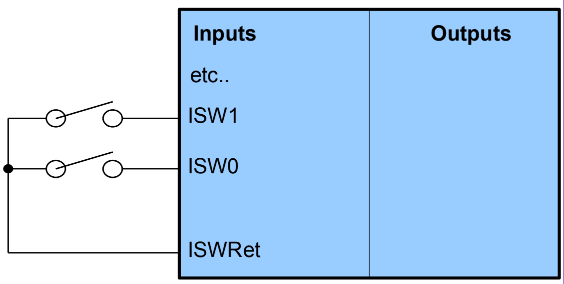
Count6, Count7 = up counters; CountQ = quadrature up/down counter.

Connection Diagram

Connecting External Devices

1. Switch Inputs ISW0..7

CPDx or EXDx Module



Switch Inputs

a) Contact Input:

Wire the contact between ISW.. and ISWRet.

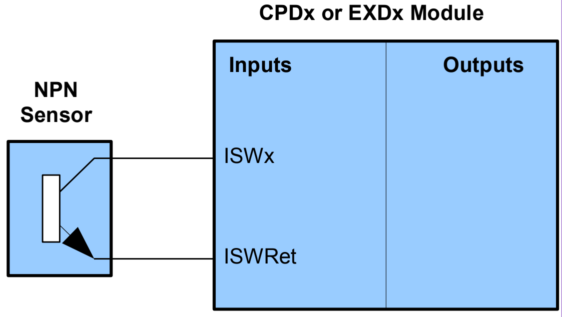
The input will be TRUE when the contact is closed.

Connecting External Devices (continued)

b) NPN Transistor Input:

Collector to ISW..
Emitter to ISWRet

The input will be TRUE when the transistor is ON.

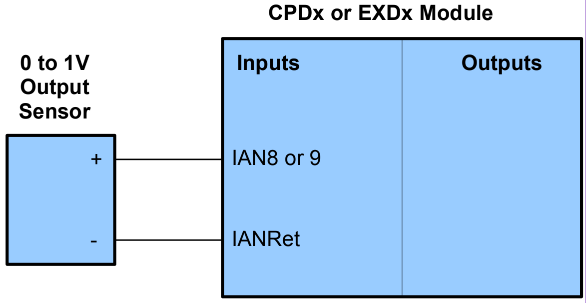


NPN Transistor Inputs

2. Analog Inputs IAN8, 9:

a) 0 to 1 V input:

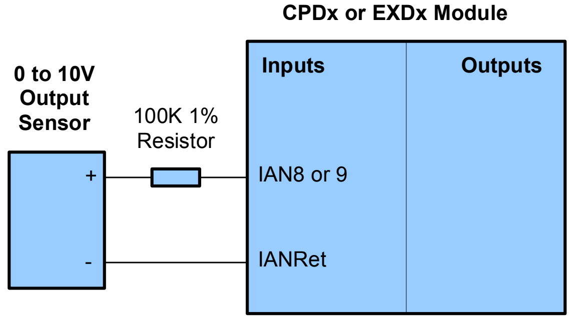
Positive to IAN8 or 9
Negative to IANRet
Remember that IANRet is not isolated from the PLC 0V line.



0-1V Analogue Inputs

b) 0 to 10 V input:

Positive to a 100 Kohm 1% resistor
Other side of the resistor to IAN8 or 9
Input resistance of IAN8 and IAN9 is 11.1 Kohm ± 0.1%.
Negative of the input to IANRet
Remember that IANRet is not isolated from the PLC 0V line.

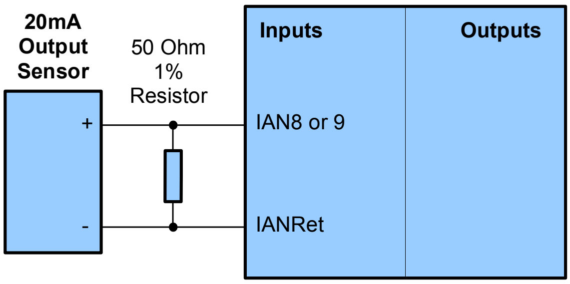


0-10V Analogue Input

Connecting External Devices (continued)

c) 0 to 20 mA or 4 to 20 mA input:

Wire a 50 ohm 1% resistor between IAN8 or 9 and IANRet.
Positive input to IAN8 or 9 (and the resistor).
Negative input to IANRet.
Remember that IANRet is not isolated from the PLC 0V line, so the PLC must be the lowest device in the loop.
In the case of 4-20 mA input, 4 mA will input 0.20 to the diagram, and 20 mA will input 1.00 to the diagram.

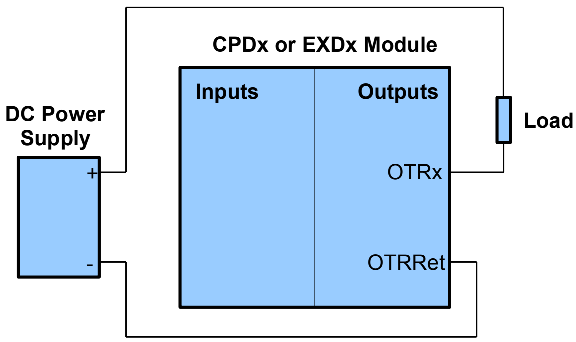


20mA Analogue Input

3. Transistor Outputs OTR0..7:

a) Resistive Loads:

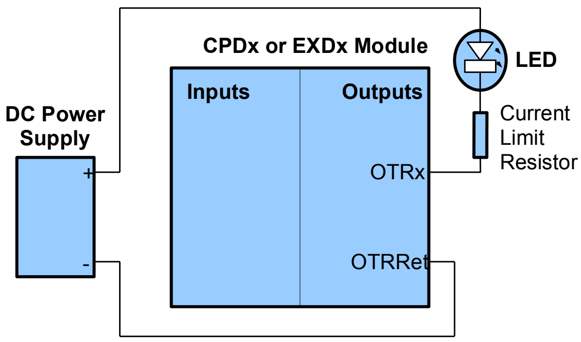
Negative terminal of the power supply feeding the load to OTRRet.
Positive terminal of the load to the positive terminal of the power supply.
Negative terminal of the load to OTR0..7 as required.
Note that OTRRet is connected to the PLC 0V line.



Resistive Load

b) LEDs:

Determine whether the LED is fitted with a current limiting circuit.
Most LEDs are not, and will need a current limiting resistor wired in series with them.

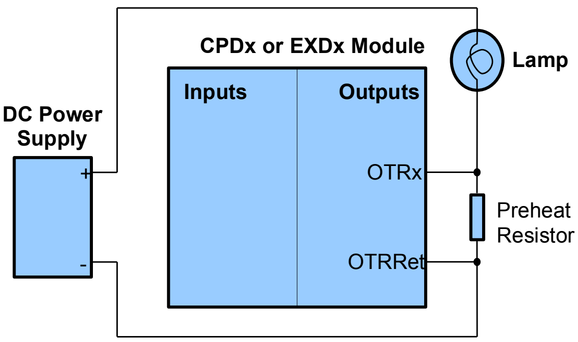


LED Load

Connecting External Devices (continued)

c) Filament Lamps:

The problem with filament lamps is the extremely low resistance when cold, giving rise to a huge current surge when switched on. One approach is to put a current limiting resistor in series with the lamp - the power supply voltage then needs to be greater than the lamp voltage.

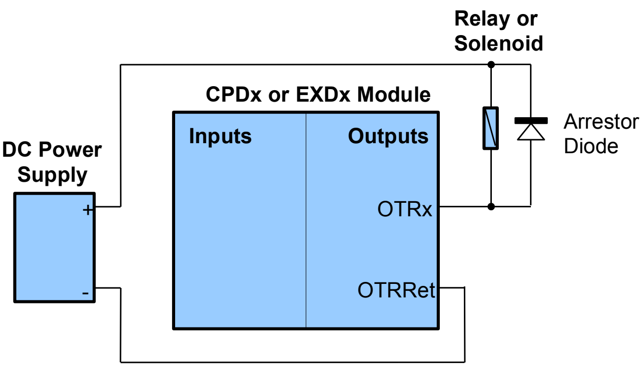


Filament Lamp Load

An alternative approach is to shunt the switching device with a preheat resistor whose value is such that the filament is just at the glow point when the lamp is switched off.
This approach can greatly increase lamp life where lamps are switched on and off frequently, e.g. where a lamp is flashed as a warning.

d) Relays and Solenoids:

Inductive loads such as relays and solenoids normally need arrestor diodes across them to protect the switching element. AmbiLogique transistor outputs have VDR protection so that the diodes are not strictly necessary, unless the load is being switched frequently.
However, fitting the diodes will reduce the voltage spikes associated with switching off inductive loads, and improve EMC performance.



Inductive Load

e) Small DC Motors:

Small DC motors with a full load current of up to 1 amp can be driven directly from the transistor outputs OTRx of the CPDx or EXDx module.
There is a problem with starting these motors, as the start current will be many times the full load current. This will either blow the output transistor or (as we have often seen) pull the power supply down so that a PLC reset is caused.
This problem can be overcome by using two outputs: one is for starting and has a current limiting resistor in series; both are activated once the motor has started. Normally a timer can be used to sequence the two outputs.
Choose a resistor which will pass 1 amp when the motor is stalled.

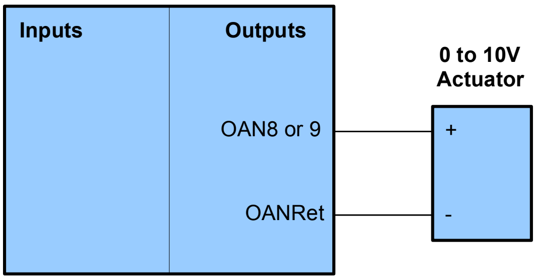
Connecting External Devices (continued)

4. Analogue Outputs OAN 8 and 9:

a) Voltage Output (0 to 10 V):

The OAN8 and OAN9 outputs have an internal resistance of 100 ohms. If the load has a significant resistance, the output voltage will be less than expected.
Most 0-to-10 V devices have input resistances greater than 100 Kohms, so the loading error will be less than 0.1% .

CPDx or EXDx Module

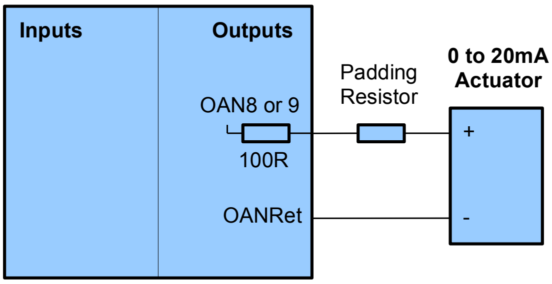


0-10V Analogue Output

b) Current Output (0 to 20 mA):

The total circuit resistance including loads, the internal resistance of 100 ohms, and the padding resistor needs to total 500 ohms.
An output value of 10.0 from the diagram will produce 20 mA.
An output value of 2.0 will produce 4 mA.
For a simpler and better controlled 0-20 or 4-20 mA output scheme, see the data sheet for the EXDA-4201 Expansion Module.

CPDx or EXDx Module



0-20mA Analogue Output

WARNING
SAFETY-CRITICAL SYSTEMS

A Safety-Critical system is a system whose failure or malfunction could cause death, significant injury or loss of property.

AmbiLogique products incorporate electronic hardware and software, both of which carry a remote but real possibility of failure. AMBILOGIQUE DOES NOT WARRANT, CLAIM OR REPRESENT THAT ITS PRODUCTS ARE INFALLIBLE.

It is therefore THE RESPONSIBILITY OF THE DESIGNER of any safety-critical system which incorporates AmbiLogique products to ensure that:-

1. The system is designed so that any failure of an AmbiLogique component will not cause death, injury or loss of property.
2. The system incorporates independent monitoring means which detect the failure of any of the electronic control elements.
3. The system has alternative and independent means of control which enable it to be controlled and shut down in an orderly manner.
4. Any and all other industry-specific safety requirements are fully implemented.

Revision History:

R 0.0	2016-01-21	Initial issue – update on CPDA-01 data sheet.
R1.0	2025-07-08	Revision, new sections, update to CPDA-02.

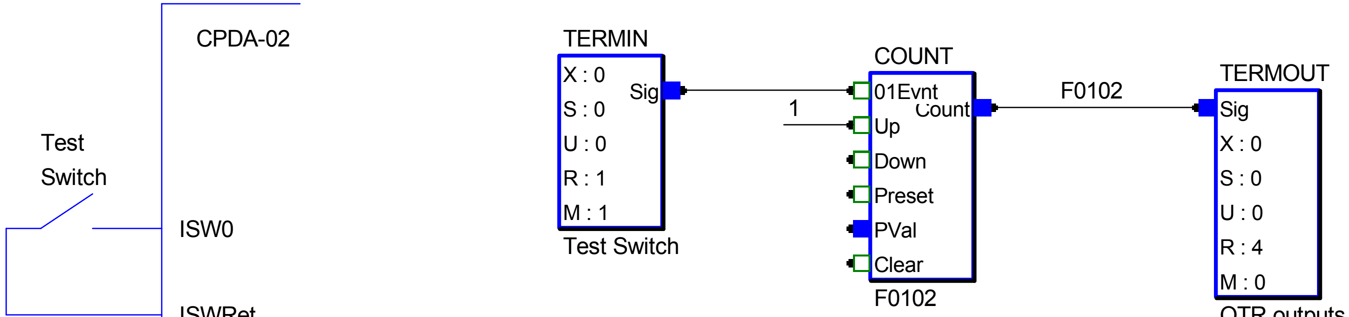


Fig. 2.1.1.
Here the switch under test is connected to ISW0.
Each time the switch is closed, the counter should advance by just ONE count.
The count is displayed on the OTRx LEDs.
Note that the R4 mask in the TERMOUT block is 0 so that it acts as an analog register.

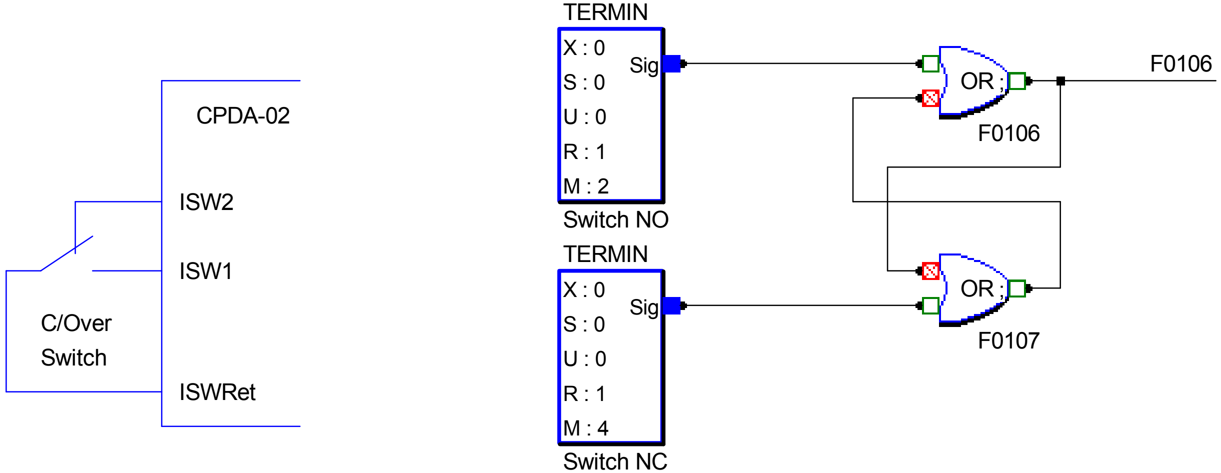


Fig. 2.1.2.
This shows the use of a latch to de-bounce a changeover switch.
Note that a latch has been constructed which is level-sensitive on both inputs,
unlike the LATSR library function, which is edge-triggered on the SET input.

REV	CHANGE	DRN	CHK	DATE
0.0	New Diagram	RJW		2022-10-18

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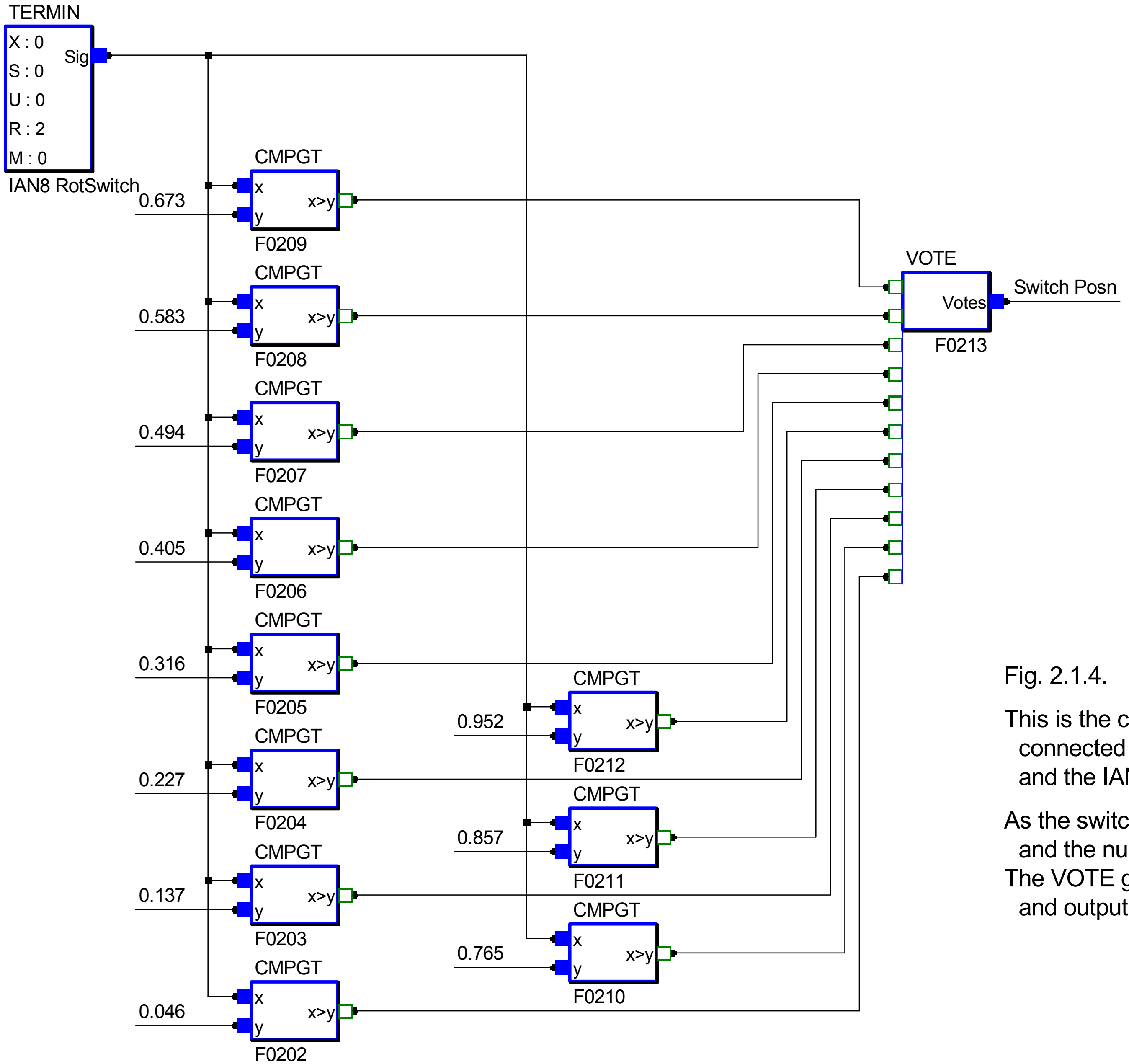
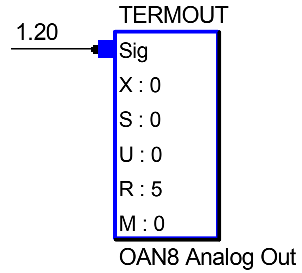
CPDA-02 Application Notes
Switch Inputs





This generates a stable voltage
for the resistor ladder.

Fig. 2.1.4.

This is the control diagram for a 12-position rotary switch connected between the OAN8 analog output and the IAN8 analog input via a resistor ladder.

As the switch rotates, the analog voltage selected by it increases, and the number of CMPGT blocks which are activated increases also. The VOTE gate counts the total number of inputs which are asserted, and outputs the switch position as 0...11.

REV	CHANGE	DRN	CHK	DATE
0.00	New Diagram	RJW		2022-10-18

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CPDA-02 Application Notes

Switch Inputs

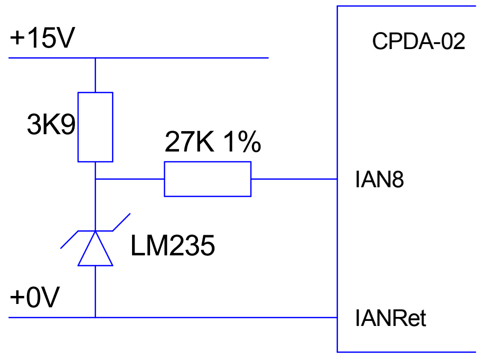

Fig. 2.1.5.
Connection diagram for LM235 temperature sensor.

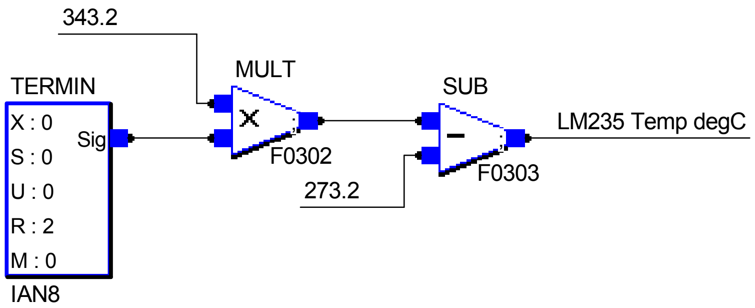

Fig. 2.1.6.
Control diagram to convert LM235 input to degrees C.

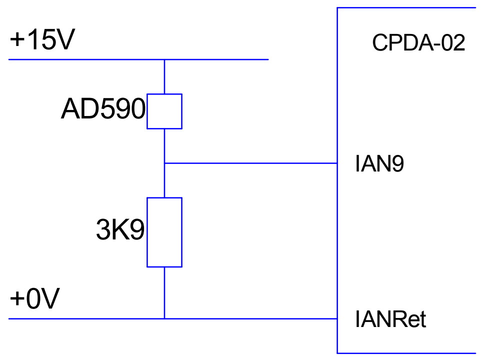

Fig. 2.1.7.
Connection diagram for AD590 temperature sensor.

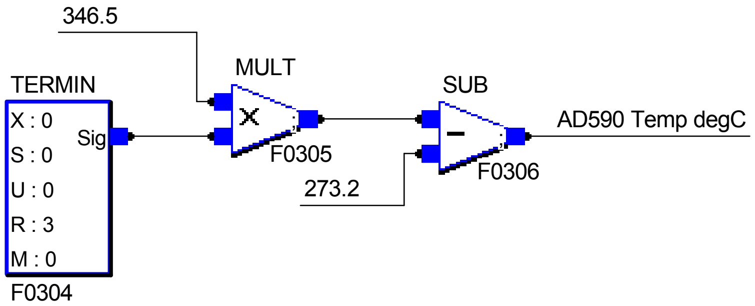

Fig. 2.1.8.
Control diagram to convert LM235 input to degrees C.

REV	CHANGE	DRN	CHK	DATE
0.00	New Diagram	RJW		2022-10-18

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CPDA-02 Application Notes
Temperature
sheet 3 of 5

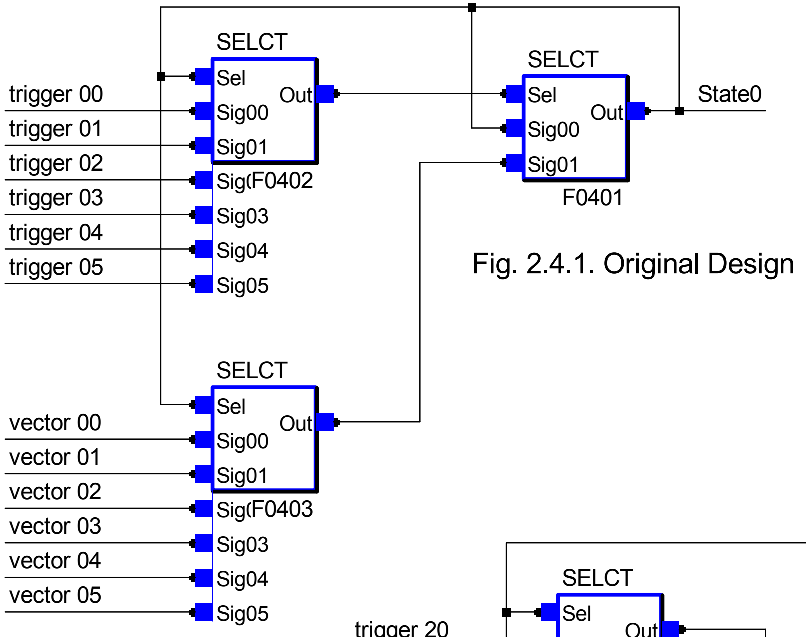

Fig. 2.4.1. Original Design

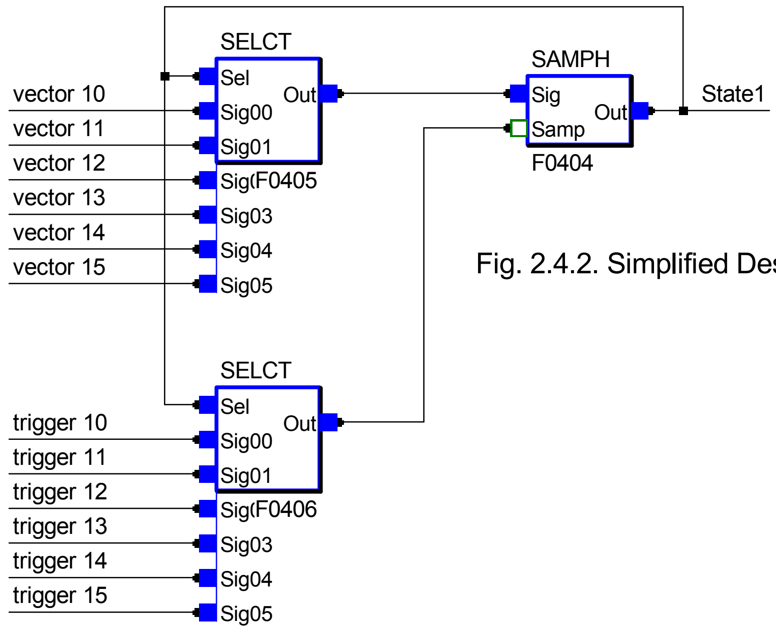

Fig. 2.4.2. Simplified Design

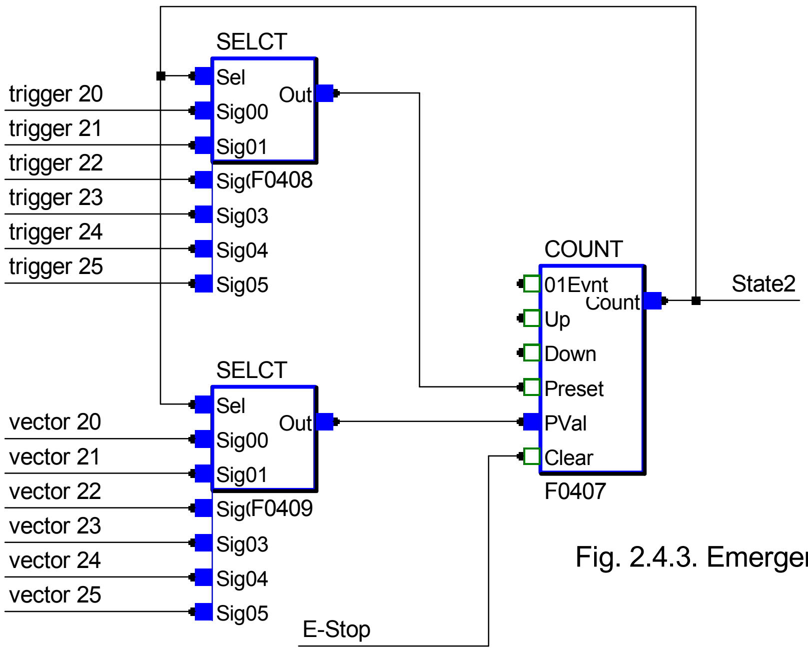

Fig. 2.4.3. Emergency Stop Design

REV	CHANGE	DRN	CHK	DATE
0.00	New Diagram	RJW		2025-07-09

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CPDA-02 Application Notes

Sequencers A

sheet 4 of 5

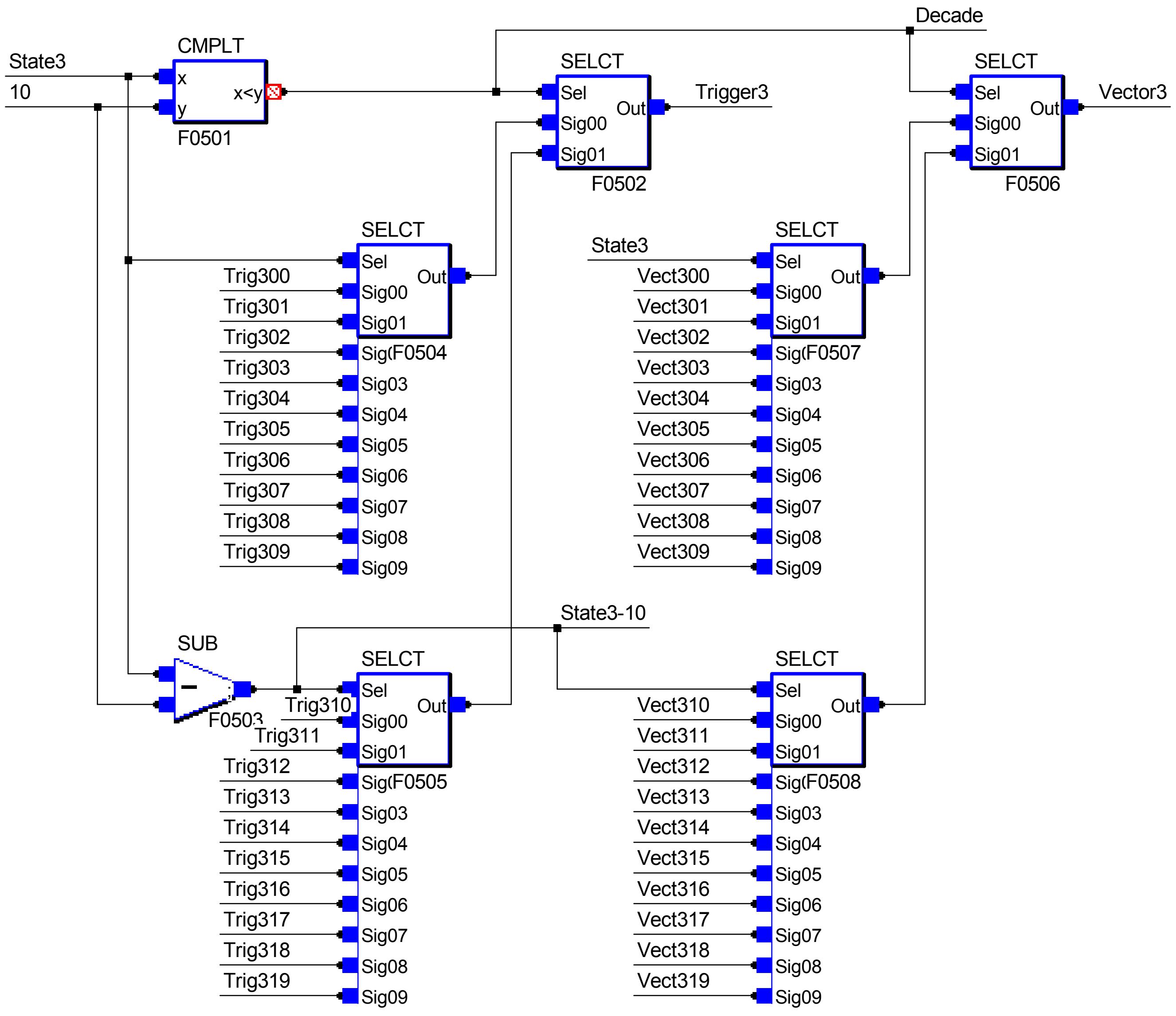

Fig. 2.4.4. Large Sequencer

REV	CHANGE	DRN	CHK	DATE
0.00	New Diagram	RJW		2025-07-09

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CPDA-02 Application Notes

Sequencers B