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APPLICATION DATA

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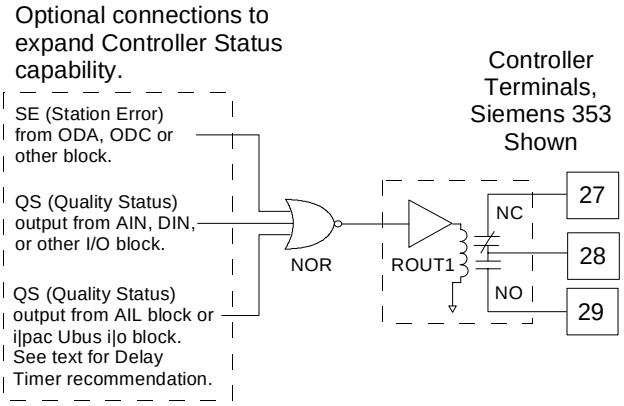
Procidia Control Solutions
Discrete Controller Status Output

In critical applications, it is often desirable to have a controller status signal to indicate that the controller is functional. This publication explains how to configure a discrete controller status output. In the figure below, the status signal is a normally open relay contact that is available to the user at terminals 28 and 29 on a Siemens Procidia™ series 353[1] controller. The relay contact is closed when the controller is functioning properly and becomes an open contact in the event of a catastrophic controller failure, a fail-open characteristic.



The controller status output contact can be used to activate one or more of the following alarm annunciators.

- A user-supplied flashing light or alarm bell
- An alarm indicator in an HMI[2] alarm display
- An e-mail alert notification
- An emergency shutdown circuit

An example of the last item occurs in a boiler application where the Burner Management System (BMS) monitors the combustion controller. If the combustion controller fails, the BMS forces a safety shut down.

While the reliability of today's process control hardware and software is better than ever, the discrete controller status techniques described here can provide an additional level of safety. In the upcoming paragraphs, various facets of the 353 controller will be explored and related to configuring a status output.

Catastrophic Controller Failure

The controller status output signals a catastrophic controller failure where the controller is unable to regulate the process. Non-catastrophic failures will not activate the controller status but will initiate an error code as described in the controller's User's Manual.

A catastrophic controller failure is usually a hardware failure. A common cause is the loss of electrical power to the controller or the failure of the controller's internal power supply. A failure of the microprocessor (hardware or software) is much less probable, but it too would render the controller non-functional. Loss of an analog input or output would be catastrophic since the process variable could not be measured or controlled.

Internal Watchdog Controller Reset

The controller's microprocessor has two internal watchdog timers that monitor controller operation. One is software and the other is hardware. The microprocessor periodically resets the watchdog timers. In the event that a watchdog fails to be reset, that watchdog will force a controller reset. During the reset, all on-board analog outputs go to zero mA and all on-board discrete outputs go to logic state zero. This will cause the controller's status contact to transition from closed to open.

[1] See Applications Support at the back of this publication for a list of controllers. For the status output application, the I/O Expander board option is needed.
[2] Such as the PC-based i|ware™ graphical HMI (Human Machine Interface) software program

Controller Status Signal

The basic controller status signal is built by configuring the output of a NOR function block to input C of an ROUT1 or ROUT2 relay output function block, as shown in the figure[3]. ROUT is an electro-mechanical relay located on the controller's I/O Expander board. The relay's contacts are available at the controller terminals for user wiring. This configuration will energize the relay output and close the normally open contact during normal operation. In the event of a catastrophic failure, this closed contact will open. Therefore, the controller status signal, at terminals 28 and 29, is a closed contact during normal controller operation and an open contact when a controller fails. The ROUT block must be configured for direct (Dir) "Action."

The most likely cause of a catastrophic controller failure is loss of power, either loss of power to the controller or failure of the controller's power supply.

Loss of external power to the controller will allow the relay contacts to open signaling a catastrophic failure.

The controller's internal power supply provides two output voltages: 5 Vdc and 24 Vdc. The 5V source is used to power the microprocessor and the discrete I/O. The 24V source powers the standard analog inputs and outputs and to energize the ROUT relays.

A failure of the 5V power source will cause the microprocessor to shut down. This will allow the hardware watchdog to timeout and reset the controller, which will open the normally open relay contact.

A 24 Vdc power source failure will disable analog I/O but allow the microprocessor to continue to function. The loss of the 24 Vdc power source is catastrophic so the status relay contacts open.

A rare cause of a nonfunctioning controller is failure of the microprocessor. If the micro-processor fails, the controller hardware watchdog will reset the controller as described above.

Station Error Bit

The ODC (Operator Display for Controllers) and the ODA (Operator Display for Analog Indication & Alarming) operator display blocks have a Station Error output. When the controller senses a severe controller error condition, the Station Error bit is set high. The list of controller errors is found in the "On-Line Error and Station Status Codes" table located in the Error Codes section of the User's Manual. Only the error codes mapped to Modbus register 40002 and LIL channel 4 affect the Station Error bit. These codes are listed on page 3.

To incorporate the Station Error into the controller status connect any SE output to a NOR block input, as shown in the figure on page 1.

Analog Input/Output Quality Status

The AIN (Analog Input) and AOUT (Analog Output) blocks have a Quality Status output. This output is normally low and goes high when the quality status is "bad."

For an AIN block, a high at the QS output indicates that there is an A/D conversion failure or that the 1-5 Vdc input signal is below 0.6V (2.4 mA). The low voltage input signal implies an open circuit or possibly a failed transmitter or other field device. (Note that when a 2-wire transmitter fails it will not necessarily cause the output current to fall below 2.4 mA.)

For an AOUT block, a high at the QS output indicates a high impedance or an open circuit.

If an analog block quality status is to be included in the controller status circuit, connect the Output QS to the NOR block input as shown above. The AOUT open circuit conditioned is already included in the Station Error bit.

Discrete Input Quality Status

The DIN (Discrete Input) blocks have a Quality Status output. A high at the QS output indicates a hardware failure in the conversion circuit. This output can be connected to the NOR block as well.

I/O Communication Blocks Quality Status

The quality status of an AIL (Analog Input Local Instrument Link) or Ethernet communication block implies a loss of network communication. This is also true of the Ubus communications between a 353R or i|pac™ controller and i|o™ modules. Since a communication network may experience a brief disruption causing the quality status to momentarily go high, a delay timer (DYT) filter is recommended if these points are to be included in the controller status.

[3] A DOUT (Discrete OUTput) block is not recommended as the controller status output.

Summary

The controller status signal provides an easily configured safety feature. By carefully selecting NOR gate inputs, the capability of the controller status can be customized to satisfy the needs of the process.

Application Support

User manuals for controllers and transmitters, addresses of Siemens sales representatives, and more application data sheets can be found at www.usa.siemens.com/ia. To reach the process controller page, click **Process Instrumentation** and then **Process Controllers and Recorders**. To select the type of assistance desired, click **Support** (in the right-hand column). See AD353-138 for a list of Application Data sheets.

The controller configurations shown in this publication can be implemented with the Siemens i|config™ Graphical Configuration Utility.

Configurations can be created and run in a:

- Model 353 Process Automation Controller
- Model 353R Rack Mount Process Automation Controller*
- i|pac™ Internet Control System*
- Model 352*Plus*™ Single-Loop Digital Controller*

* Discontinued model

Error Codes and Descriptions

Error Code	Description
MPU A/D	MPU Controller Board A/D Error
EXP A/D	I/O Expander board A/D Error
AOUT1 OC	MPU Controller Board D/A #1 Open Circuit
AOUT2 OC	MPU Controller Board D/A #2 Open Circuit
AOUT3 OC	MPU Controller Board D/A #3 Open Circuit
AINU1 AD	I/O Expander Board Universal Analog Input #1 A/D Error
AINU1 TC	I/O Expander Board Universal Analog Input #1 T/C Burnout
AINU1 RJ	I/O Expander Board Universal Analog Input #1 Reference Junction Error
AINU2 AD	I/O Expander Board Universal Analog Input #2 A/D Error
AINU2 TC	I/O Expander Board Universal Analog Input #1 T/C Burnout
AINU2 RJ	I/O Expander Board Universal Analog Input #2 Reference Junction Error
DINU1 E1	I/O Expander Board Universal Digital Input #1 Underflow Error
DINU2 E1	I/O Expander Board Universal Digital Input #2 Underflow Error
LIL ERR	LIL Port Error
LIL NUI	LIL Non Updating Error
MOD ERR	Modbus Port Error
LON ERR	LON Port Error
LON NUI	LON Non Updating Error
Watchdog	Watchdog Timeout
LOW BAT	Low NVRAM Battery Voltage
RCB->MEM	Press STORE to Load RCB Configuration into MPU Memory
CYCLETIME	Cycle Time Overrun
BURNFAIL	Flash Memory Burn Failed
RCB FAIL	RCB Board Failure
NO EXPBD	Expander Board Not Installed
PEB FAIL	Ethernet Board Failure
IP OVRUN	Ethernet Board TCP Communication Failure
MB OVRUN	Modbus Communication Failure

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