

Copley Controls I/O Module interface notes.

Digital Input / Output pins.

The module has a total of 80 digital I/O pins which are arranged in 10 banks of 8 pins each. The first 9 banks (bank A – bank I) are able to be configured as either inputs or outputs on a bank by bank basis. The 10th bank (bank J) is fixed as a digital input bank only.

All 10 banks of DIO have a number of parameters which can be used to configure their behavior. For each of these parameters, there is an object in the CANopen object dictionary which may be used to configure the bank. The object is defined as an array type object with one entry for each bank. Bank A parameters are accessed through the object sub-index 1, bank B through sub-index 2, etc. These parameters are all defined in the manufacturer's specific address space in the range 0x3000 to 0x30FF.

The following lists the parameters associated with digital input/output banks:

| <i>Object</i> | <i>Description</i> |
|----------------------|--|
| 0x3020 | Bank mode. Set to 0 for input bank. 1 for output bank. |
| 0x3021 | Input pull-up select. This parameter is only used for banks configured as input banks. The lower 8 bits of this value are used to enable on-chip pull-ups for each of the 8 pins in the bank. If a bit is set, the pull-up resistor is enabled. If the bit is clear, the corresponding pull-up is disabled. |
| 0x3022 | Open drain select. This parameter is only used for banks configured as output banks. The lower 8 bits are bit-mapped, 1 bit / pin. Set bits configure the output as an open-drain output. Clear bits configure the output as a push/pull output. |
| 0x3023 | Output fault state (output banks only). The lower 8 bits give the state that the output pin will drive to in the case of a system fault (if so configured, see object 0x3026 below). |
| 0x3024 | Input / Output pin inversion. This parameter is used for both input and output banks. Set bits will cause the input/output value to be inverted from the value set through software. |
| 0x3025 | Current input/output pin value. This object may be used to set output pins and read input pins. For inputs, the value read through this object has been filtered by the debounce filters. |
| 0x3026 | Output fault mode (output banks only). The lower 8 bits identify what action the corresponding output pin will take in the case of a fault condition. If the bit is clear, then no change on the output pin value. If set, then the fault state value will be used. |

| <i>Object</i> | <i>Description</i> |
|---------------|---|
| 0x3027 | Raw input value. This value gives the actual state of the I/O pins without any debounce applied. The inversion mask has been applied to this object however. |
| 0x3028 | Input pin interrupt mask for low to high transitions (input banks only). This object is used to select which pins will be able to generate a PDO message when the input transitions from a logical low to high state. |
| 0x3029 | Input pin interrupt mask for high to low transitions (input banks only). This object is used to select which pins will be able to generate a PDO message when the input transitions from a logical high to low state. |
| 0x3030 | Debounce time for input 0. This sets the debounce time (in ms) for the LSB input on the input bank. |
| 0x3031 | Same as 0x3030, but for the second input on the input bank. |
| 0x3032 | Same as 0x3030, but for the third input on the input bank. |
| 0x3033 | Same as 0x3030, but for the fourth input on the input bank. |
| 0x3034 | Same as 0x3030, but for the fifth input on the input bank. |
| 0x3035 | Same as 0x3030, but for the sixth input on the input bank. |
| 0x3036 | Same as 0x3030, but for the seventh input on the input bank. |
| 0x3037 | Same as 0x3030, but for the eighth input on the input bank. |

In addition to these manufacturer specific objects, some bank parameters also have a CANopen standard mapping in the object dictionary. For these parameters the setting may be accessed through either location. One major difference between the CANopen object mappings and the manufacturer specific mappings is that the CANopen standard mappings are indexed differently for input banks and output banks.

For CANopen standard parameter settings, there is no concept of banks that can be programmable as input or outputs. A particular object will apply only to the input banks or only to the output banks. Sub-indexes within the object will be used to identify the Nth object of the particular type (input or output) in the system. Thus, the bank selected by a particular sub-index of a CANopen standard object will depend on how the banks are configured, as inputs or outputs.

For example, if banks A-C and G-J are all configured as input banks, and banks D-F are configured as output banks, then the CANopen objects that relate to input bank settings will address the input banks using the following sub-indexes:

| <i>Input bank</i> | <i>Standard object Sub-index</i> | <i>Copley object sub-index</i> |
|-------------------|----------------------------------|--------------------------------|
| A | 1 | 1 |
| B | 2 | 2 |
| C | 3 | 3 |
| G | 4 | 7 |
| H | 5 | 8 |
| I | 6 | 9 |
| J | 7 | 10 |

To further complicate matters, the CANopen standard allows its inputs to be accessed and configured in units of 8, 16 and 32 pins. When the objects that deal with 8-pin groups are used, then the sub-indexes described above are used. When the 16-bit objects are used, then each sub-index of the object accesses two of the I/O banks. When the 32-bit objects are used, then each sub-index accesses 4 of the I/O banks.

The following standard CANopen objects are supported. This table gives the standard CANopen object ID, the size of the access, and the corresponding 0x3000 object for reference.

| <i>Standard object</i> | <i>Width</i> | <i>Copley object</i> | <i>Description</i> |
|------------------------|--------------|----------------------|---------------------------------|
| 0x6000 | 8 | 0x3025 | Input bank value |
| 0x6002 | 8 | 0x3024 | Input bank inversion |
| 0x6007 | 8 | 0x3028 | Input bank low->high interrupts |
| 0x6008 | 8 | 0x3029 | Input bank high->low interrupts |
| 0x6100 | 16 | 0x3025 | Input bank value |
| 0x6102 | 16 | 0x3024 | Input bank inversion |
| 0x6107 | 16 | 0x3028 | Input bank low->high interrupts |
| 0x6108 | 16 | 0x3029 | Input bank high->low interrupts |
| 0x6120 | 32 | 0x3025 | Input bank value |
| 0x6122 | 32 | 0x3024 | Input bank inversion |
| 0x6127 | 32 | 0x3028 | Input bank low->high interrupts |
| 0x6178 | 32 | 0x3029 | Input bank high->low interrupts |
| 0x6200 | 8 | 0x3025 | Output bank value |

| <i>Standard object</i> | <i>Width</i> | <i>Copley object</i> | <i>Description</i> |
|------------------------|--------------|----------------------|-------------------------|
| 0x6202 | 8 | 0x3024 | Output bank inversion |
| 0x6206 | 8 | 0x3026 | Output bank fault mode |
| 0x6207 | 8 | 0x3023 | Output bank fault value |
| 0x6300 | 16 | 0x3025 | Output bank value |
| 0x6302 | 16 | 0x3024 | Output bank inversion |
| 0x6306 | 16 | 0x3026 | Output bank fault mode |
| 0x6307 | 16 | 0x3023 | Output bank fault value |
| 0x6320 | 32 | 0x3025 | Output bank value |
| 0x6322 | 32 | 0x3024 | Output bank inversion |
| 0x6326 | 32 | 0x3026 | Output bank fault mode |
| 0x6327 | 32 | 0x3023 | Output bank fault value |

Analog input configuration:

The I/O module includes 12 analog inputs. These inputs are 12-bit values at the hardware level. The module provides a 32-bit scaling value and offset which may be used to scale the inputs into convenient units for the master.

There are a number of objects in the CANopen object dictionary which may be used to configure these inputs. In most cases there are two different objects which may be used to access each parameter; one CANopen standard object and another in the 0x3000 range of the object dictionary. The existence of the second object is more a side effect of the implementation and can generally be ignore. Either the CANopen standard object, or the 0x3000 area object may be used.

Analog input setup objects:

| <i>CANopen object</i> | <i>Copley object</i> | <i>Description</i> |
|-----------------------|----------------------|--|
| 0x6400 | | 8-bit version of scaled analog input value |
| 0x6401 | | 16-bit version of scaled analog input value |
| 0x6402 | 0x3041 | 32-bit version of scaled analog input value. |
| 0x6421 | 0x304A | Interrupt mask. This identifies which conditions can cause the analog input to generate a PDO. The bits are mapped as follows: 0 – Upper limit exceeded |

| <i>CANopen object</i> | <i>Copley object</i> | <i>Description</i> |
|-----------------------|----------------------|--|
| | | <p>1 – Input below lower limit</p> <p>2 – Input changed by more then absolute delta value.</p> <p>3 – Input reduced by more then the negative delta</p> <p>4 – Input increased by more then the positive delta</p> |
| 0x6422 | 0x301A | <p>This object identifies which analog input(s) are currently experiencing an interrupt condition.</p> <p>The standard object uses sub-index 1 to send the value and is 32-bits wide. The Copley object uses sub-index 0 and is 16-bits wide.</p> |
| 0x6423 | 0x301B | Global interrupt enable. Must be set to 1 to enable any PDOs from analog inputs. All access is through sub-index 0. |
| 0x6424 | 0x3044 | Upper analog limit. The input can be configured to generate a PDO if it exceeds this value. |
| 0x6425 | 0x3045 | Lower analog limit. The input can be configured to generate a PDO if it falls below this value. |
| 0x6426 | 0x3046 | Absolute delta limit. A change in the input by more then this amount since it was last sent can be configured to trigger a PDO. |
| 0x6427 | 0x3048 | Negative delta limit. A decrease in the input by more then this amount since it was last sent can be configured to trigger a PDO. |
| 0x6428 | 0x3047 | Positive delta limit. An increase in the input by more then this amount since it was last sent can be configured to trigger a PDO. |
| 0x6431 | 0x3043 | Offset. This 32-bit value is added to the analog value after it is scaled by 0x6432. |
| 0x6432 | 0x3042 | <p>32-bit scaling factor. The raw analog reading is scaled by this value. If the 32-bit version of the analog input is read, then it is the raw value multiplied by this scaler. If the 16-bit version is read, then it's the upper 16-bits of the 32-bit version. If the 8-bit version is read, then the upper most 8 bits is returned.</p> <p>All delta values and levels are based on the 32-bit scaled version of the analog inputs. Typically, the scaled value is viewed as having a integer part (upper 16 bits) and a fractional part (lower 16 bits). The default scaling value is 0x10000 which would correspond to a scaling of 1.0 in this view.</p> |

PWM Output configuration:

The I/O module contains 12 PWM outputs which are configured in two banks of 6. The PWM duty cycle of each output can be set individually, however the PWM period can only be set for the entire bank.

The following objects may be used to configure the PWM outputs:

| <i>CANopen Object</i> | <i>Copley Object</i> | <i>Description</i> |
|-----------------------|----------------------|--|
| 0x6410 | | 8-bit PWM value. This sets the upper most 8 bits of the scaled PWM value. |
| 0x6411 | | 16-bit PWM value. This sets the upper most 16 bits of the scaled PWM value. |
| 0x6412 | 0x3051 | 32-bit PWM value. This sets the full version of the scaled PWM value. |
| 0x6446 | 0x3053 | 32-bit offset value. This is added to the PWM value after it has been scaled by 0x6447. The result is written to the hardware. |
| 0x6447 | 0x3052 | 32-bit scaling factor. This is multiplied by the 32-bit PWM value written to objects 0x6410, 0x6411 or 0x6412. |
| | 0x301E | PWM period for bank A. The period is set in nanosecond units and may range from 1000 to 4,000,000. |
| | | PWM period for bank B. |