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 configured 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:

Object	***Description***
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.

Object	*Description*
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:

Input bank	*Standard object Sub-index*	*Copley object sub-index*
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 it's 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.

Standard object	*Width*	*Copley object*	*Description*
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

Standard object	*Width*	*Copley object*	*Description*
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:

CANopen object	*Copley object*	*Description*
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

CANopen object	*Copley object*	*Description*
		1 – Input below lower limit 2 – Input changed by more then absolute delta value. 3 – Input reduced by more then the negative delta 4 – Input increased by more then the positive delta
0x6422	0x301A	This object identifies which analog input(s) are currently experiencing an interrupt condition. 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.
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	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. 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.

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:

CANopen Object	***Copley Object***	***Description***
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.