Application Note #1438

Description of the IOM-1964

***Description*:**

- Provides 64 optically isolated inputs and outputs, each rated for 24mA at up to 28 VDC
- Configurable as inputs or outputs in groups of eight bits
- Provides 16 high power outputs capable of up to 500mA each
- Two versions:
  1. **IOM-1964-80**: Recommended for all Optima Series Controllers except the DMC-1600 series. Connects to the controller via an 80 pin shielded cable.
  2. **IOM-1964-100**: Used only for the DMC-1600 Controller. Connects to the controller via the 100 pin shielded cable.
- All I/O points conveniently labeled
- Each of the 64 I/O points has status LED
- Dimensions 6.8” x 11.4”

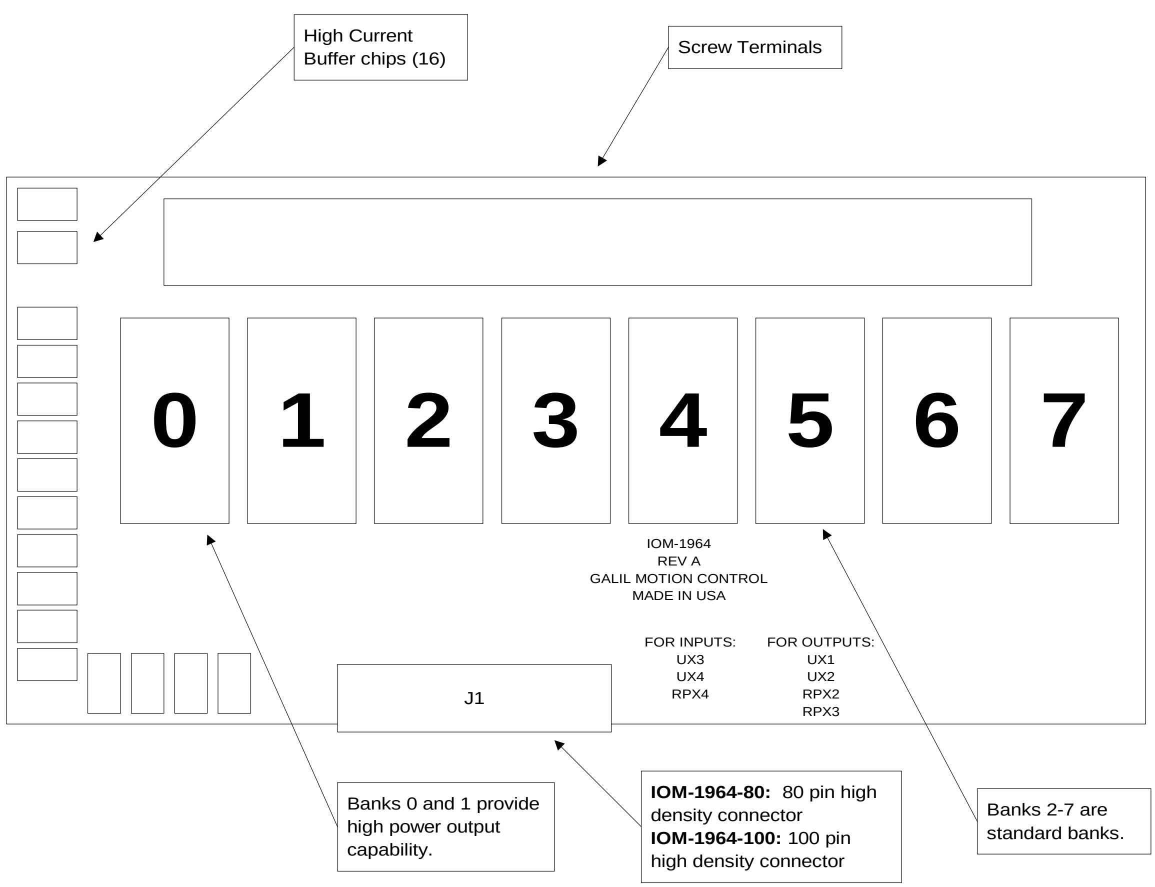

Figure 1: Board Layout

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Overview

The IOM-1964 is an input/output module that connects to the motion controller cards from Galil, providing optically isolated buffers for the extended inputs and outputs of the controller. The IOM-1964 also provides 16 high power outputs capable of 500mA of current per output point.

The IOM-1964 separates the 64 I/O points into eight banks of eight I/O points each, corresponding to the eight banks of extended I/O on the controller. These banks are denoted as Bank0 through Bank7. Each bank is individually configured as an input or output bank by inserting the appropriate integrated circuits and resistor packs. The hardware configuration of the IOM-1964 must match the software configuration of the controller card.

All Optima Series controllers have general purpose I/O connections. Four-axis Optima Series controllers have the following uncommitted I/O standard: eight optically isolated digital inputs, eight TTL digital outputs, and eight analog inputs.

The following Optima Series controllers have an additional 64 digital input/output points referred to as *extended I/O*:

1. All DMC-12x8 controllers (x = 1 to 8)
2. All DMC-13x8 controllers (x = 1 to 4)
3. All DMC-16x0 controllers (x = 1 to 4)
4. All DMC-17x8 controllers (x = 1 to 4)
5. All DMC-20x0 controllers (x = 1 to 8)
6. All DMC-21x0 controllers (x = 1 to 8)
7. All DMC-22x0 controllers (x = 1 to 8)

For cabling information, see the recommended cable and configuration diagrams in the application note for the specific controller to be used.

Discussion of I/O Configuration:

The extended I/O on the Galil Optima controllers is considered as an extension to the general outputs. Optima controllers may have up to 16 general outputs, which are numbered 1-16. The 64 extended I/O points are numbered 17-80. In addition, the auxiliary encoder inputs are also mapped to this I/O space if the user chooses to use these inputs for general use. The auxiliary encoder inputs are numbered as inputs 81-96. Each set of 8 I/O points is considered a ***block***. NOTE: The term "***block***" is used when referring to groups of I/O as part of the entire I/O space of the controller. The term "***bank***" refers to the groups of I/O on the IOM-1964.

Optima I/O is configured in the following manner:

Name	Block	Description	Controller	
In 1-8	Block 0	***General Input***	All Optima Controllers	
In 9-16	Block 1	***General Input***	Available on all Optima Controllers with 5 or more axes	**General Inputs**
In 17-24	Block 2	***General Input***	Only Available w/ DMC-1700 (5-8 axes) Only Available w/ DMC-1800 (5-8 axes)	
Out 1-8	Block 0	***General Output***	All Optima Controllers	**General Outputs**
Out 9-16	Block 1	***General Output***	Available on all Optima Controllers with 5 or more axes	
I/O 17-24	Block 2	***Extended I/O***	DMC-12x8,-13x8,-16x0,-17x8,-2xx0	
I/O 25-32	Block 3	***Extended I/O***	DMC-12x8,-13x8,-16x0,-17x8,-2xx0	
I/O 33-40	Block 4	***Extended I/O***	DMC-12x8,-13x8,-16x0,-17x8,-2xx0	
I/O 41-48	Block 5	***Extended I/O***	DMC-12x8,-13x8,-16x0,-17x8,-2xx0	**Extended I/O**
I/O 49-56	Block 6	***Extended I/O***	DMC-12x8,-13x8,-16x0,-17x8,-2xx0	
I/O 57-64	Block 7	***Extended I/O***	DMC-12x8,-13x8,-16x0,-17x8,-2xx0	
I/O 65-72	Block 8	***Extended I/O***	DMC-12x8,-13x8,-16x0,-17x8,-2xx0	
I/O 73-80	Block 9	***Extended I/O***	DMC-12x8,-13x8,-16x0,-17x8,-2xx0	
In 81-82	Block10	***X AuxEncoder***	All Optima Controllers	
In 83-84	Block10	***Y AuxEncoder***	Controllers with 2 or more axes	
In 85-86	Block10	***Z AuxEncoder***	Controllers with 3 or more axes	
In 87-88	Block10	***W AuxEncoder***	Controllers with 4 or more axes	**Auxiliary Encoder Inputs**
In 89-90	Block10	***E AuxEncoder***	Controllers with 5 or more axes	
In 91-92	Block10	***F AuxEncoder***	Controllers with 6 or more axes	
In 93-94	Block10	***G AuxEncoder***	Controllers with 7 or more axes	
In 95-96	Block10	***H AuxEncoder***	Controllers with 8 or more axes	

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Configuring Hardware Banks

The extended I/O on the controller is configured using the CO command. The banks of buffers on the IOM-1964 are configured to match by inserting the appropriate IC's and resistor packs. The layout of each of the I/O banks is identical. For example, here is the layout for bank 0:

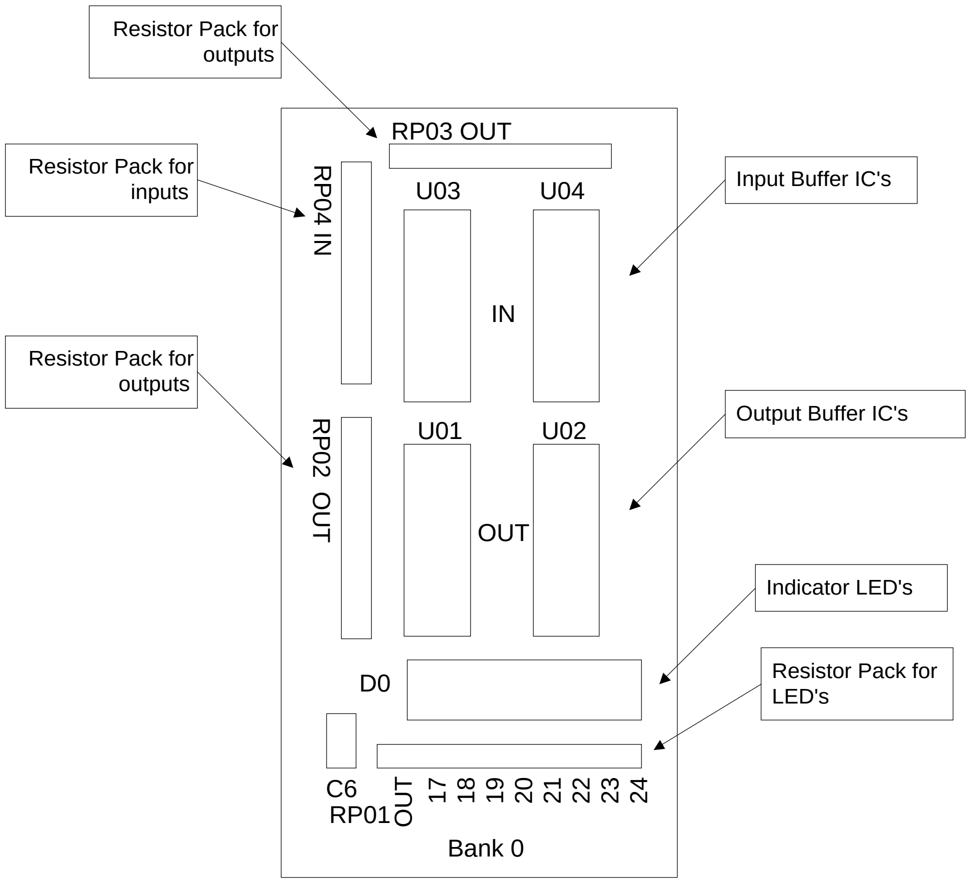

Figure 2: Hardware Bank Configuration

All banks have the same configuration pattern as displayed above. For example, all banks have Ux1 and Ux2 output optical isolator IC sockets, labeled in Bank 0 as U01 and U02, in Bank 1 as U11 and U12, and so on. Each bank is configured as inputs or outputs by inserting optical isolator IC's and resistor packs in the appropriate sockets. A group of eight LED's indicates the status of each I/O point. The numbers above the 'Bank 0' label indicate the number of the I/O point corresponding to the LED above it.

Digital Inputs

Bank 0 and Bank 1:

Note that Bank 0 and Bank 1 are unique in their configuration. Galil recommends that these banks be used for outputs since they have been specially designed for driving high current loads. NOTE: In order to use these banks as inputs, the IOM-

1964 connection labeled OUTCn **must** be connected to the isolated power supply ground. Please refer to the diagrams below.

Configuring a bank for inputs requires that the Ux3 and Ux4 sockets be populated with NEC2506 optical isolation integrated circuits. The IOM-1964 is shipped with a default configuration of banks 2-7 configured as inputs. The output IC sockets Ux1 and Ux2 must be empty. The input IC's are labeled Ux3 and Ux4. For example, in Bank 0 the IC's are U03 and U04, Bank 1 input IC's are labeled U13 and U14, and so on. Also, the resistor pack RPx4 must be inserted into the bank to finish the input configuration.

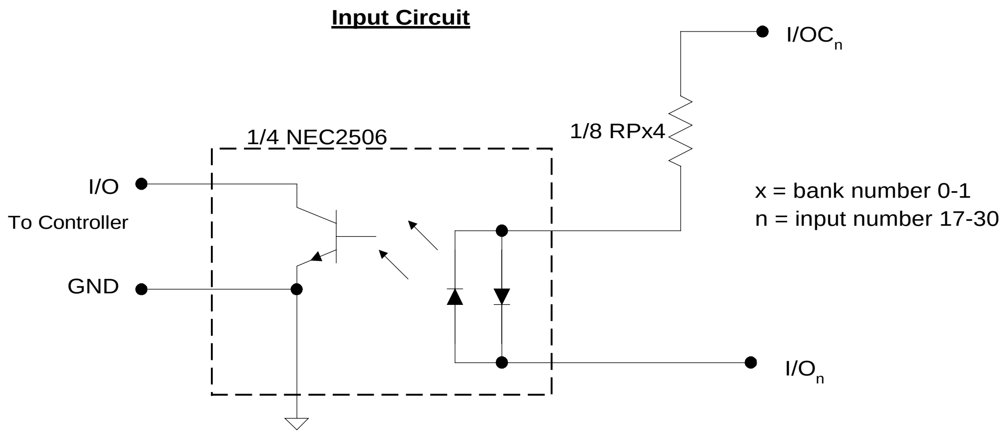

Figure 3: Input Circuit

Connections to the inputs for Bank 0 and Bank 1 must be made for current sinking, referring to the direction of current as shown below:

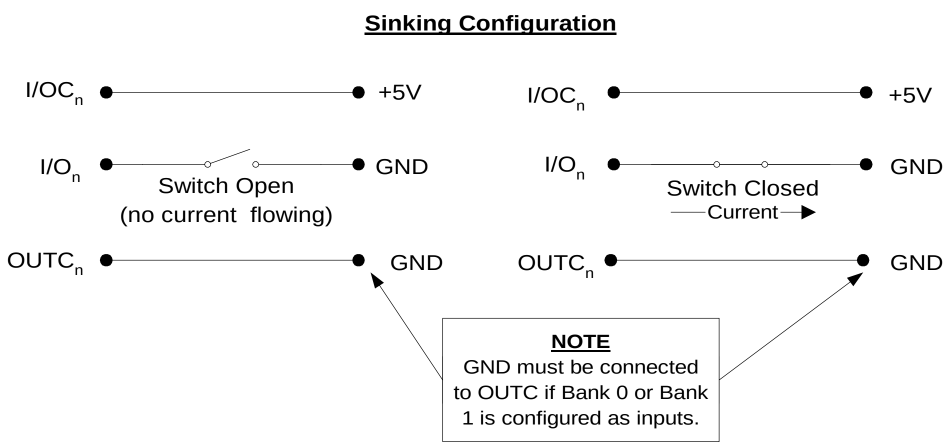

Figure 4: Sinking Configuration

There is one I/OC connection for each bank of eight inputs. When the switch is open, no current flows and the digital input function @IN[n] returns 1. This is due to an internal pull up resistor on the controller. When the switch is closed, the input on the controller is connected to ground (current flows), and the digital input function @IN[n] returns 0.

Active outputs are connected to the optically isolated inputs in a similar fashion with respect to current. Generally, for a sinking configuration an NPN output is used (PNP outputs are used for sourcing configuration which is not acceptable for Bank 0 or Bank 1).

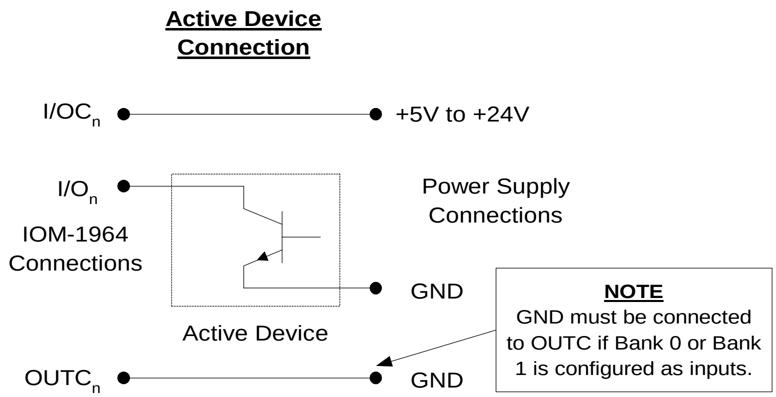

Figure 5: Active Device Connection

When the NPN output is high, then no current flows and the input reads 1. When the NPN output goes to 0 Volts, then it sinks current and the input reads 0.

Note that the current through the digital input should be kept below 3 mA in order to minimize the power dissipated in the resistor pack. This will help prevent circuit failures. The resistor pack RPx4 is standard 1.5 kOhm, which is suitable for power supply voltages up to 5.5 VDC. However, use of 24 VDC for example would require a higher resistance such as a 10 kOhm resistor pack.

Bank 2 through Bank 7:

Configuring a bank for inputs requires that the Ux3 and Ux4 sockets be populated with NEC2506 optical isolation integrated circuits. The default configuration from Galil has banks 2-7 configured as inputs. The output IC sockets Ux1 and Ux2 must be empty. The input IC's are labeled Ux3 and Ux4. For example, in Bank 2 the IC's are U23 and U24, Bank 3 input IC's are labeled U33 and U44, and so on. Also, the resistor pack RPx4 must be inserted into the bank to finish the input configuration.

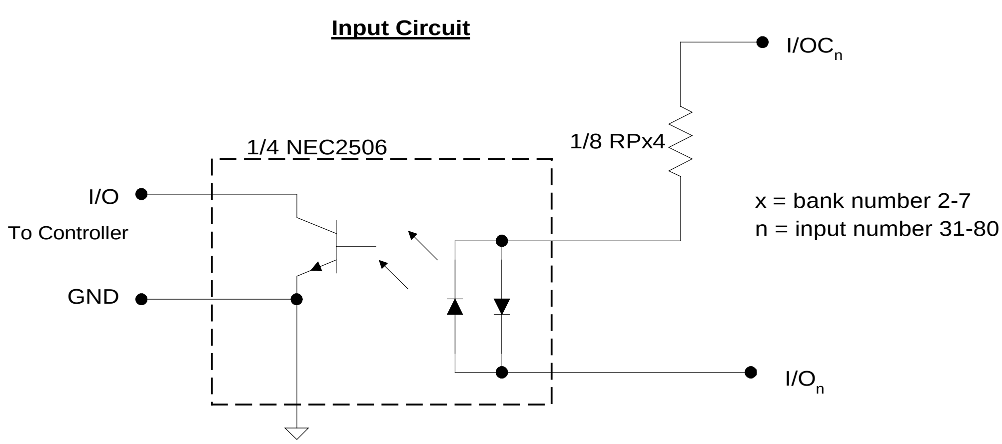

Figure 6: Input Circuit

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Connections to this optically isolated input circuit are done in a sinking or sourcing configuration, referring to the direction of current. Some example circuits are shown below:

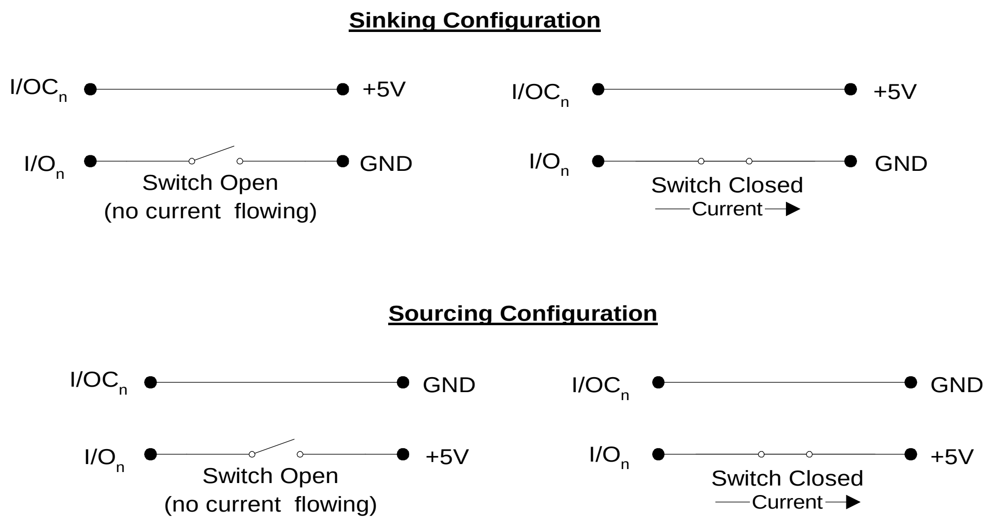

Figure 7: Sinking and Sourcing Configurations

There is one I/OC connection for each bank of eight inputs. Whether the input is connected as sinking or sourcing, when the switch is open no current flows and the digital input function @IN[n] returns 1. This is because of an internal pull up resistor on the controller. When the switch is closed in either circuit, current flows and the digital input function @IN[n] returns 0. Note that the external +5V in the circuits above is for example only. The inputs are optically isolated and can accept a range of input voltages from 4 to 28 VDC.

Active outputs are connected to the optically isolated inputs in a similar fashion with respect to current. An NPN output is connected in a sinking configuration, and a PNP output is connected in the sourcing configuration.

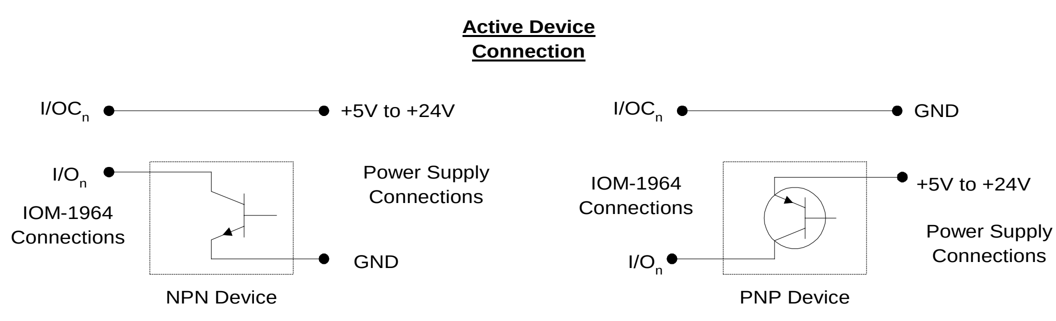

Figure 8: Active Device Connections

Whether connected in a sinking or sourcing circuit, only two connections are needed in each case. When the NPN output is 5 Volts, no current flows and the input reads 1. When the NPN output goes to 0 Volts, then it sinks current and the input reads 0. The

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PNP output works in a similar fashion but the voltages are reversed, i.e. 5 Volts on the PNP output sources current into the digital input and the input reads 0. As before, with the 5 Volt as an example, the I/OC can accept between 4-28 Volts DC.

Note that the current through the digital input should be kept below 3 mA in order to minimize the power dissipated in the resistor pack. This will help prevent circuit failures. The resistor pack RPx4 is standard 1.5 kOhm, which is suitable for power supply voltages up to 5.5 VDC. However, use of 24 VDC for example would require a higher resistance such as a 10 kOhm resistor pack.

High Power Digital Outputs

The first two banks on the IOM-1964, Banks 0 and 1, have high current output drive capability. The IOM-1964 is shipped with Banks 0 and 1 configured as outputs. Each output can drive up to 500 mA of continuous current. To configure a bank of I/O as outputs, insert the optical isolator NEC2506 IC's into the Ux1 and Ux2 sockets. The digital input IC's Ux3 and Ux4 are removed. The resistor packs RPx2 and RPx3 are inserted, and the input resistor pack RPx4 is removed.

Each bank of eight outputs shares one I/OC connection, which is connected to a DC power supply between 4 and 28 VDC. A 10 kOhm resistor pack should be used for RPx3. Here is a circuit diagram:

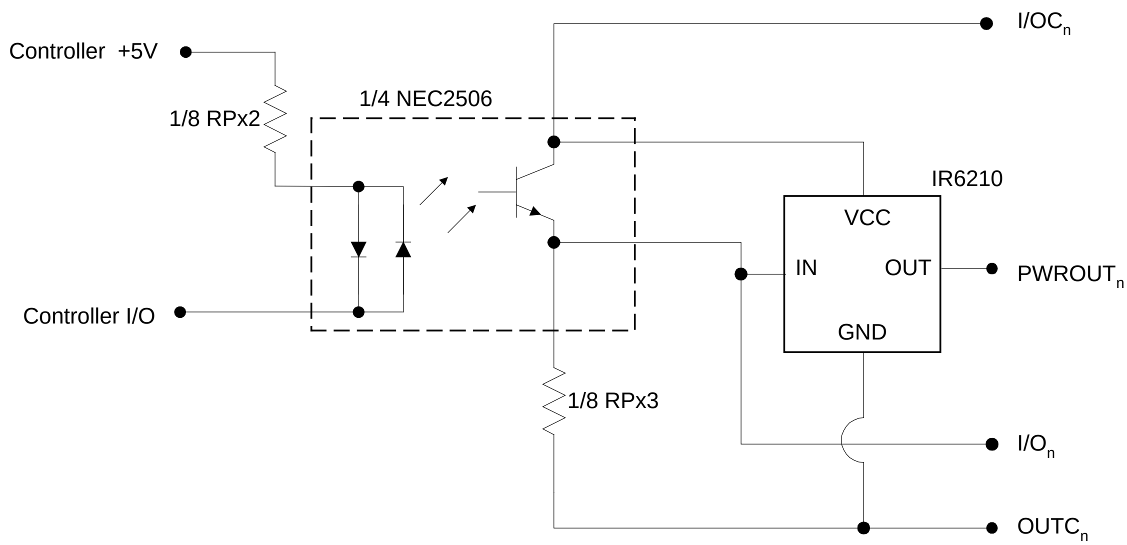

Figure 9: Power Outputs

The load is connected between the power output and output common. The I/O connection is for test purposes, and would not normally be connected. An external power supply is connected to the I/OC and OUTC terminals, which isolates the circuitry of the controller from the output circuit.

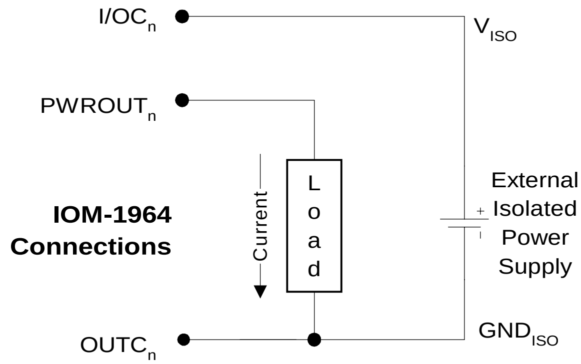

Figure 10: Load Connection

The power outputs must be connected in a driving configuration as shown on the previous page. Here are the voltage outputs to expect after the Clear Bit and Set Bit commands are given:

Output Command	**Result**
CB_n	$V_{pwr} = V_{iso}$
SB_n	$V_{pwr} = GND_{iso}$

Standard Digital Outputs

The I/O Banks 2-7 can be configured as optically isolated digital outputs, however these banks do not have the high power capacity as in Banks 0-1. In order to configure a bank as outputs, the optical isolator chips Ux1 and Ux2 are inserted, and the digital input isolator chips Ux3 and Ux4 are removed. The resistor packs RPx2 and RPx3 are inserted, and the input resistor pack RPx4 is removed.

Each bank of eight outputs shares one I/OC connection, which is connected to a DC power supply between 4 and 28 VDC. The resistor pack RPx3 is optional, used either as a pull up resistor from the output transistor's collector to the external supply connected to I/OC or the RPx3 is removed resulting in an open collector output. Here is a schematic of the digital output circuit:

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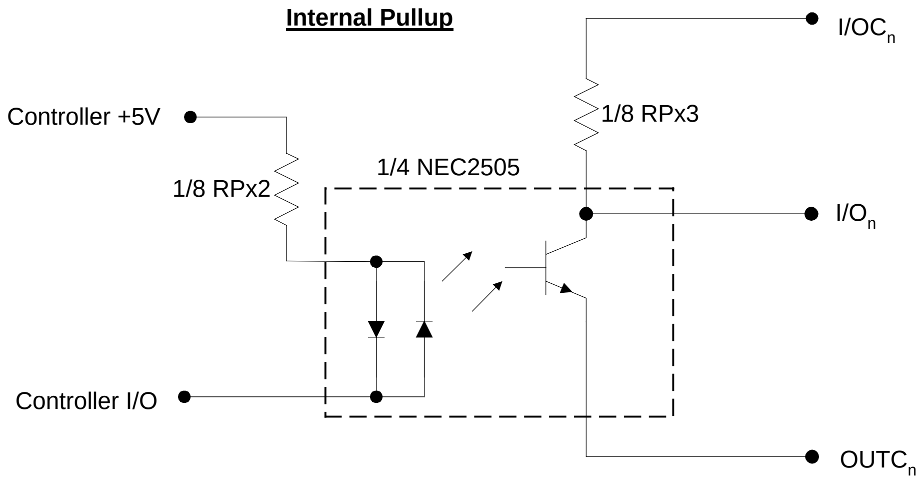

Figure 11: Internal Pullup

The resistor pack RPx3 limits the amount of current available to source, as well as affecting the low level voltage at the I/O output. The maximum sink current is 24mA regardless of RPx3 or I/OC voltage, determined by the NEC2506 optical isolator IC. The maximum source current is determined by dividing the external power supply voltage by the resistor value of RPx3.

The high level voltage at the I/O output is equal to the external supply voltage at I/OC. However, when the output transistor is on and conducting current, the low level output voltage is determined by three factors. The external supply voltage, the resistor pack RPx3 value, and the current sinking limit of the NEC2506 all determine the low level voltage. The sink current available from the NEC2506 is between 0 and 24 mA. Therefore, the maximum voltage drop across RPx3 is calculated by multiplying the 24 mA maximum current times the resistor value of RPx3. For example, if a 10 kOhm resistor pack is used for RPx3, then the maximum voltage drop is 20 Volts. The digital output will never drop below the voltage at OUTC, however. Therefore a 10 kOhm resistor pack will result in a low level voltage of 0.7 to 1.0 Volts at the I/O output for an external supply voltage between 4 and 21 VDC. If a supply voltage greater than 21 VDC is used, a higher value resistor pack will be required.

Output Command	Result
CB_n	$V_{out} = GND_{iso}$
SB_n	$V_{out} = V_{iso}$

The resistor pack RPx3 is removed to provide open collector outputs. The same calculations for maximum source current and low-level voltage apply as in the above circuit. The maximum sink current is determined by the NEC2506, and is approximately 24 mA.

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Open Collector

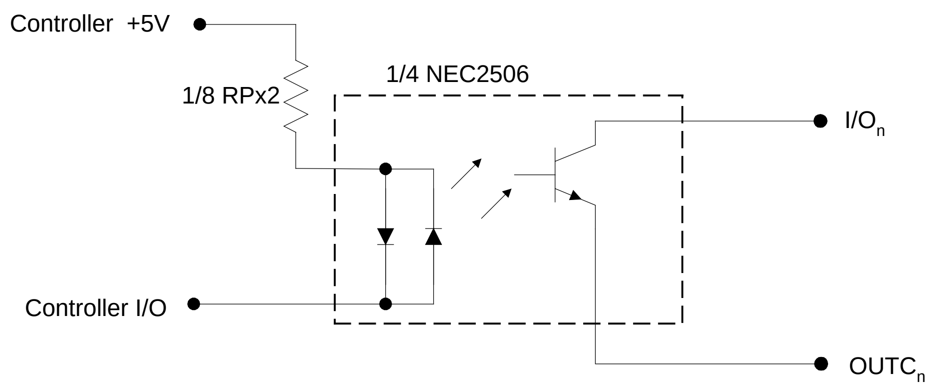

Figure 12: Open Collector Circuit

Electrical Specifications

- I/O points, configurable as inputs or outputs in groups of 8

Digital Inputs

- Maximum voltage: 28 VDC
- Minimum input voltage: 4 VDC
- Maximum input current: 3 mA

High Power Digital Outputs

- Maximum external power supply voltage: 28 VDC
- Minimum external power supply voltage: 4 VDC
- Maximum source current, per output: 500mA
- Maximum sink current: sinking circuit inoperative

Standard Digital Outputs

- Maximum external power supply voltage: 28 VDC
- Minimum external power supply voltage: 4 VDC
- Maximum source current: limited by pull up resistor value
- Maximum sink current: 24mA

Relevant DMC Commands

CO n	Configures the 64 bits of extended I/O in 8 banks of 8 bits each. $N = n_0 + 2*n_1 + 4*n_2 + 8*n_3 + 16*n_4 + 32*n_5 + 64*n_6 + 128*n_7$ where n_x is a 1 or 0, 1 for outputs and 0 for inputs. The x is the bank number
OP m,n,o,p,q	m = 8 standard digital outputs n = extended I/O banks 0 & 1, outputs 17-32 = extended I/O banks 2 & 3, outputs 33-48 p = extended I/O banks 4 & 5, outputs 49-64 q = extended I/O banks 6 & 7, outputs 65-80

SB n	Sets the output bit to a logic 1, n is the number of the output from 1 to 80.
CB n	Clears the output bit to a logic 0, n is the number of the output from 1 to 80.
OB n,m	Sets the state of an output as 0 or 1, also able to use logical conditions.
TI n	Returns the state of 8 digital inputs as binary converted to decimal, n is the bank number +2.
_TI n	Operand (internal variable) that holds the same value as that returned by TI n.
@IN[n]	Function that returns state of individual input bit, n is number of the input from 1 to 80.

Visual Display of Extended I/O command usage

Output Port	OP m		OP, a		OP,,b		OP,,,c		OP,,,,d	
Bank	**B0**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**B9**
I/O range	1-8	9-16	17-24	25-32	33-40	41-48	49-56	57-64	65-72	73-80
Configure Outputs	CO n = Σ		1+	2+	4+	8+	16+	32+	64+	128

**If corresponding bank (B2 thru B9) should be configured as an Output Bank, then include above number in SUM and use in CO command

Screw Terminal Listing

TERM	LABEL	DESCRIPTION	BANK
1	GND	Ground pins of J1	N/A
2	5V	5V DC out from J1	N/A
3	GND	Ground pins of J1	N/A
4	5V	5V DC out from J1	N/A
5	I/O80	I/O bit 80	BANK 7
6	I/O79	I/O bit 79	BANK 7
7	I/O78	I/O bit 78	BANK 7
8	I/O77	I/O bit 77	BANK 7
9	I/O76	I/O bit 76	BANK 7
10	I/O75	I/O bit 75	BANK 7
11	I/O74	I/O bit 74	BANK 7

12	I/O73	I/O bit 73	BANK 7
13	OUTC73-80	Out common for I/O 73-80	BANK 7
14	I/OC73-80	I/O common for I/O 73-80	BANK 7
15	I/O72	I/O bit 72	BANK 6
16	I/O71	I/O bit 71	BANK 6
17	I/O70	I/O bit 70	BANK 6
18	I/O69	I/O bit 69	BANK 6
19	I/O68	I/O bit 68	BANK 6
20	I/O67	I/O bit 67	BANK 6
21	I/O66	I/O bit 66	BANK 6
22	I/O65	I/O bit 65	BANK 6
23	OUTC65-72	Out common for I/O 65-72	BANK 6
24	I/OC65-72	I/O common for I/O 65-72	BANK 6
25	I/O64	I/O bit 64	BANK 5
26	I/O63	I/O bit 63	BANK 5
27	I/O62	I/O bit 62	BANK 5
28	I/O61	I/O bit 61	BANK 5
29	I/O60	I/O bit 60	BANK 5
30	I/O59	I/O bit 59	BANK 5
31	I/O58	I/O bit 58	BANK 5
32	I/O57	I/O bit 57	BANK 5
33	OUTC57-64	Out common for I/O 57-64	BANK 5
34	I/OC57-64	I/O common for I/O 57-64	BANK 5
35	I/O56	I/O bit 56	BANK 4
36	I/O55	I/O bit 55	BANK 4
37	I/O54	I/O bit 54	BANK 4
38	I/O53	I/O bit 53	BANK 4
39	I/O52	I/O bit 52	BANK 4
40	I/O51	I/O bit 51	BANK 4
41	I/O50	I/O bit 50	BANK 4
42	I/O49	I/O bit 49	BANK 4
43	*OUTC49-56	Out common for I/O 49-56	BANK 4
44	I/OC49-56	I/O common for I/O 49-56	BANK 4
45	I/O48	I/O bit 48	BANK 3
46	I/O47	I/O bit 47	BANK 3
47	I/O46	I/O bit 46	BANK 3
48	I/O45	I/O bit 45	BANK 3
49	I/O44	I/O bit 44	BANK 3
50	I/O43	I/O bit 43	BANK 3
51	I/O42	I/O bit 42	BANK 3
52	I/O41	I/O bit 41	BANK 3
53	OUTC41-48	Out common for I/O 41-48	BANK 3

TERM	LABEL	DESCRIPTION	BANK
54	I/OC41-48	I/O common for I/O 41-48	BANK 3
55	I/O40	I/O bit 40	BANK 2
56	I/O39	I/O bit 39	BANK 2
57	I/O38	I/O bit 38	BANK 2
58	I/O37	I/O bit 37	BANK 2
59	I/O36	I/O bit 36	BANK 2
60	I/O35	I/O bit 35	BANK 2
61	I/O34	I/O bit 34	BANK 2
62	I/O33	I/O bit 33	BANK 2
63	OUTC33-40	Out common for I/O 33-40	BANK 2
64	I/OC33-40	I/O common for I/O 33-40	BANK 2
65	I/O32	I/O bit 32	BANK 1
66	I/O31	I/O bit 31	BANK 1
67	I/O30	I/O bit 30	BANK 1
68	I/O29	I/O bit 29	BANK 1
69	I/O28	I/O bit 28	BANK 1
70	I/O27	I/O bit 27	BANK 1
71	I/O26	I/O bit 26	BANK 1
72	I/O25	I/O bit 25	BANK 1
73	OUTC25-32	Out common for I/O 25-32	BANK 1
74	*I/OC25-32	I/O common for I/O 25-32	BANK 1
75	*OUTC25-32	Out common for I/O 25-32	BANK 1
76	I/OC25-32	I/O common for I/O 25-32	BANK 1
77	PWROUT32	Power output 32	BANK 1
78	PWROUT31	Power output 31	BANK 1
79	PWROUT30	Power output 30	BANK 1
80	PWROUT29	Power output 29	BANK 1
81	PWROUT28	Power output 28	BANK 1
82	PWROUT27	Power output 27	BANK 1
83	PWROUT26	Power output 26	BANK 1
84	PWROUT25	Power output 25	BANK 1
85	I/O24	I/O bit 24	BANK 0
86	I/O23	I/O bit 23	BANK 0
87	I/O22	I/O bit 22	BANK 0
88	I/O21	I/O bit 21	BANK 0
89	I/O20	I/O bit 20	BANK 0
90	I/O19	I/O bit 19	BANK 0
91	I/O18	I/O bit 18	BANK 0
92	I/O17	I/O bit 17	BANK 0
93	OUTC17-24	Out common for I/O 17-24	BANK 0
94	*I/OC17-24	I/O common for I/O 17-24	BANK 0
95	*OUTC17-24	Out common for I/O 17-24	BANK 0

96	I/OC17-24	I/O common for I/O 17-24	BANK 0
97	PWROUT24	Power output 24	BANK 0
98	PWROUT23	Power output 23	BANK 0
99	PWROUT22	Power output 22	BANK 0
100	PWROUT21	Power output 21	BANK 0
101	PWROUT20	Power output 20	BANK 0
102	PWROUT19	Power output 19	BANK 0
103	PWROUT18	Power output 18	BANK 0
104	PWROUT17	Power output 17	BANK 0

*Silkscreen on Rev A board is incorrect for these terminals.