ACE3_2   CBUS module for Control Panels.   12V version.

Revised 12/02/2011.   Applies to firmware Rev m onwards

Introduction

ACE3_2 is one of a number of layout control modules for use with the CBUS system. This is a general purpose layout control bus (LCB) using the industry standard CAN bus. For more information on CBUS, see the introductory article on the website. (www.cbus.org.uk)

ACE3_2 is a ‘producer ’ only module which sends events over the CBUS to consumer modules. It is intended for use on conventional control panels with ‘mimic’ diagrams to operate turnouts or set complete routes.

ACE3_2 can operate in either the SLiM (Simple) or FLiM (Full) mode. The default is SLiM

When in SLiM mode, ACE3_2 can be given a Node Number (NN) by onboard jumpers. No programming is necessary. For practical reasons, the present ACE3_2 module only allows 4 node numbers to be set. This limits the number of control panels using this module to 4. However, like all other SLiM modules, it responds with its CAN-ID when interrogated by ‘nodes’ which implement the self-enumeration scheme so is compatible with the Full Model modules (FLiM). In FLiM mode the node number limit is much greater, up to 65534.

ACE3_2 can scan up to 128 on / off switches creating 128 ON / OFF events or, by changing an on-board jumper, can scan 64 pairs of push-buttons (PBs) or ‘centre off’ toggle switches, giving 64 separate ON or OFF events. When in Full mode, more options are available.

Please refer to the schematic ACE3_2_sch.pdf.

Power supply

ACE3_2 in common with all _2 modules requires an external 12V DC supply. A common 12V supply can be used for all _2 CBUS modules. Power input is via the CBUS connector pins 1 (0V) and 4 (+12V).

There is a separate voltage regulator (U2) which supplies the rest of the circuit with a fixed 5V. This regulator should not require a heatsink.

In SLiM mode, the green LED (LD2) will illuminate to show the circuit is working correctly. This is not just a power on indicator but confirms correct working of the processor. When in FLiM mode the yellow LED (LD1) shows correct running.

The switch matrix scanning method.

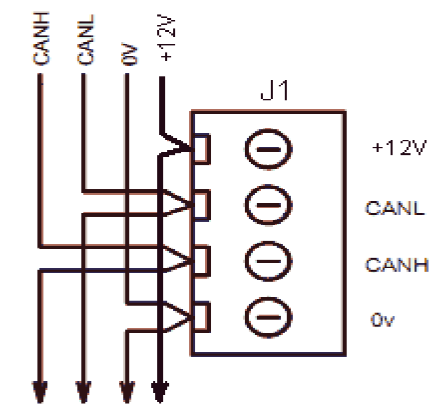
The control panel switches are interrogated using a conventional diode matrix method. This allows a large number of switches to be connected with relatively little wiring. Only 24 wires for 128 switches or 64 PB pairs. The matrix is arranged as 16 columns and 8 rows. Each column is pulsed from 5V (high) to 0V (low) in turn on a cyclical basis. The rows are connected to the columns via a switch and a series diode. If a switch is closed, the corresponding row is taken low when the column goes low. The voltage drop across the series diode still gives a logic low with the CMOS inputs of the PIC processor. Unlike similar arrangements for keypad scanning where only one button is pressed at one time, the diodes are required as switches may remain closed. If pushbuttons only are used, the diodes are not necessary.

The processor firmware detects changes in the switches or PBs and sends a corresponding CBUS event. When in switch mode, a switch closure sends an ON event and a switch opening sends an OFF event. In accord with the CBUS protocol, the event is a 32 bit (4 byte) number. The upper two bytes are the Node Number, in the case of ACE3_2 in SLiM mode, this range is 1 to 4 only. The lower two bytes are the node event. Again, for ACE3_2, these switch numbers start at 1 and run sequentially to 128 (or 1 to 64 for the dual pushbutton mode). Event or NN of zero is not used.

To further simplify the control panel wiring, the numbering sequence starts at 1 with column 1 and row 1, 2 with column 1 and row 2, 3 with column 1 and row 3 and 4 with column 1 and row 4. However, event 5 is column 2 and row 1 (not column 1 and row 5) so only the first 4 rows are used for events 1 to 64 and the second set of rows (5 to 8) for events 65 to 128. This allows for a sequential set of events for smaller control panels using only 4 row wires total. The same applies in PB mode but each column generates 2 events for the 4 rows so rows 1 to 4 give events 1 to 32 and rows 5 to 8 give events 33 to 64. All matrix wiring is conveniently supplied via a 25 way D type socket. The pinout is given on the schematic.

Selection of switch mode or push button mode is via the jumper J5. J5 has three pins. Placing the jumper between the centre and lower pins sets ‘switch’ mode and between the centre and upper pins, selects the PB mode. (Viewed with the regulator U2 at the top) When in FLiM mode, this jumper is disregarded.

Connecting the module



The CANH and CANL wires go to all modules. They are polarity sensitive so CANH must go to CANH and CANL to CANL. These wires should preferably be a twisted pair but it is not essential, especially for short distances. Screening is not necessary. The 0V must also be connected to all modules.

Where a number of modules are powered off the same 12V DC supply, then their 12V input terminals should all be connected together. If separate 12V supplies are used, the 0V should be commoned.

While it would be usual to wire the bus sequentially round the various modules, it is not essential and individual nodes can be 'star' connected if this is more convenient. The CBUS wiring should be kept separated from any DCC supply wiring to prevent possible interference.

The CAN bus requires 'termination' resistors at some point in the network. If the bus is wired sequentially round the modules, then a resistor of 120 ohms should be fitted across the bus at each end. For small layouts, it is sufficient to have a resistor across the bus at one point. The value is not critical and a 68 ohm resistor will suffice.

Note: Where the CBUS contains a mixture of the older AC powered modules and the current DC powered modules the 12V DC should be independent of the AC supply, **not** derived from the same transformer. Only the CANH, CANL and 0V should be connected between AC and DC powered modules.

Setting the node number in SLiM mode.

Purely due to hardware constraints (not enough pins on the PIC) the ACE3_2 module only allows 4 node numbers. These are selected as a binary sequence with jumpers Sel 0 and Sel 1. The actual binary numbers are 0, 1, 2 and 3 although the firmware adds one so the NNs run from 1 to 4. A logical 0 is with the jumper in.

The following table gives all the possible combinations. The node number may be changed while the module is running.

Sel 1	Sel 0	Node Number
in	in	1
in	out	2
out	in	3
out	out	4

As with all CBUS producer modules, no two modules should have the same Node Number. Thus, if a layout uses all four ACE3_2 modules in SLiM mode, other producer modules should start at Node Number 5. If only one ACE3_2 module is used, it is recommended to set it at Node Number 1 and then others can start at 2. In the unusual case where you may want two identical control panels, having the same switch arrangement and controlling exactly the same devices, it is possible to give them both the same Node Number. They will then produce identical events for each switch.

Notes.

The presently available CAN transceivers set a maximum number of CAN nodes on any one 'segment' to 110. Although the current SLiM scheme only allows 99 producer modules, there is no limit to the number of consumer modules so care must be taken not to overload the CAN bus. The Full Model (FLiM) scheme allows for 65536 modules which will be programmable over the CBUS itself. Here, we intend to develop modules to bridge between many CAN segments (CAN-CANs).

The PCBs include provision for in-circuit serial programming and debugging (ICSP). The firmware also contains code for use with the CBUS bootloader so code can be updated over the CBUS. (see document 'CBUS_Bootloader.pdf)

The small pushbutton S1 is intended for use if the module is upgraded to the Full (FLiM) model. It is not used in SLiM mode or with the SLiM firmware and can be omitted. To put the module into FLiM mode, hold the PB in for at least 8 seconds. The green LED will extinguish. Release the PB and the yellow LED will flash. The module now needs to be given its node number (NN). The yellow LED will go steady. Configuration in FLiM mode requires a PC and suitable CAN interface (the CAN_USB module is recommended). A comprehensive Config. Tool software package is available.

Additional facilities in FLiM mode

1. Switch options.

There is a node variable (NV) which defines the switch combinations.

Mode 0	All switches work as ON / OFF toggles (same as SLiM with the jumper to 0v)	
Mode 1	All pushbutton pairs (same as SLiM with the jumper to +5V)	
Mode 2	Top 4 rows	Toggles, bottom 4 rows PB pairs
Mode 3	Top 4 rows	Toggles, bottom 4 rows PB ON only
Mode 4	Top 4 rows	PB pairs, bottom 4 rows PB ON only
Mode 5		All PB ON only

The value entered in the NV defines the mode.

2. Changing the event produced by individual switches.

Each switch in the matrix looks in a table for the event to send. This table comprises the default values initially or after an event clear command. The entry or table ‘index’ is the switch number. In FLiM learn mode, the event is taught by reference to this index value. The event can be either a long event (4 bytes) or a short event where the top two bytes are 0. The short event allows each switch to have a designated ‘device number’ suited to recognition by a computer based control scheme. The device number is the lower two bytes of the taught event.

With the relative complexity of the switch matrix, it may not be easy to work out or remember which physical switch has which ‘switch number’. If the module is put into its FLiM learn mode, you can activate a switch and the module will produce an event (5 bytes) with the last byte being the switch number. Hence the PC can identify the correct index value for that switch and allocate the device number accordingly.

A stored event can also be read back by reference to its index.

The above process is catered for in a simple fashion by the software Config. Tool.

For operation in the Full mode (FLiM), see the document ‘Full_mode_operation.pdf
The full schematic, a PCB layout which is in .PDF form and can be printed to the exact size for making masks and the PIC assembly and HEX code are available on the MERG website. These can be freely used for non-commercial purposes.