

Electronics for Model Railways



Chapter 16

Introduction to CBUS

By Davy Dick

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In memory of Margaret



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An introduction to CBUS

Many excellent layouts would further benefit from improved efficiency and greater functionality if it could successfully tackle a couple of problems:

- The huge amount of wires and connectors used, particularly on layouts built using multiple boards.
- The lack of two-way communication, getting feedback from points, train detectors, automating some features, even adding computer control.

The CBUS 2-wire layout control system was developed by Mike Bolton and Gil Fuchs as an open standard to tackle these issues.

Lets start by looking at some the problems with traditional layout wiring.

The conventional way

These layouts have a central control panel that is used to activate points, switch lights etc. This involves running wires from each switch and pushbutton to each point, light or accessory. On a large layout, this results in masses of wires running under the baseboard. Where multiple boards are used, this collection of wires has to be carried over between baseboard sections, using multipole plugs and sockets.

The sheer number of wires and connections increases the complexity and fault liability of the layout.

The DCC way

The previous chapter on DCC showed how points and accessories can be operated by sending signals along with the DCC power. Accessory decoder modules connect across the track and get their instructions from the command station.

This cuts down on wiring, with the accessory decoders only requiring power from the layout's power bus when handling high-current devices.

In many respects, it is a 2-wire control system, although it is was really designed for one-way communication – from the command station to the decoders.

Although the NMRA recognises the need for bi-direction working (see RP-9.3.1 and RP-9.3.2), it is about the loco decoder sending information back to the command station.

Helpful though this is, it does not cater for a range of other needs such as a point or track detector sending back information.

The other limitation is how the accessory decoders are controlled by the operator. While some operators are happy to use buttons on a handheld controller, many would still prefer to be able to operate the layout's points and accessories from a control panel.

They would also like feedback on track occupancy, etc. to be fed back to the control panel. Another limitation of DCC is that all control passes through the command station and there is no provision for local autonomous activities using the DCC bus.

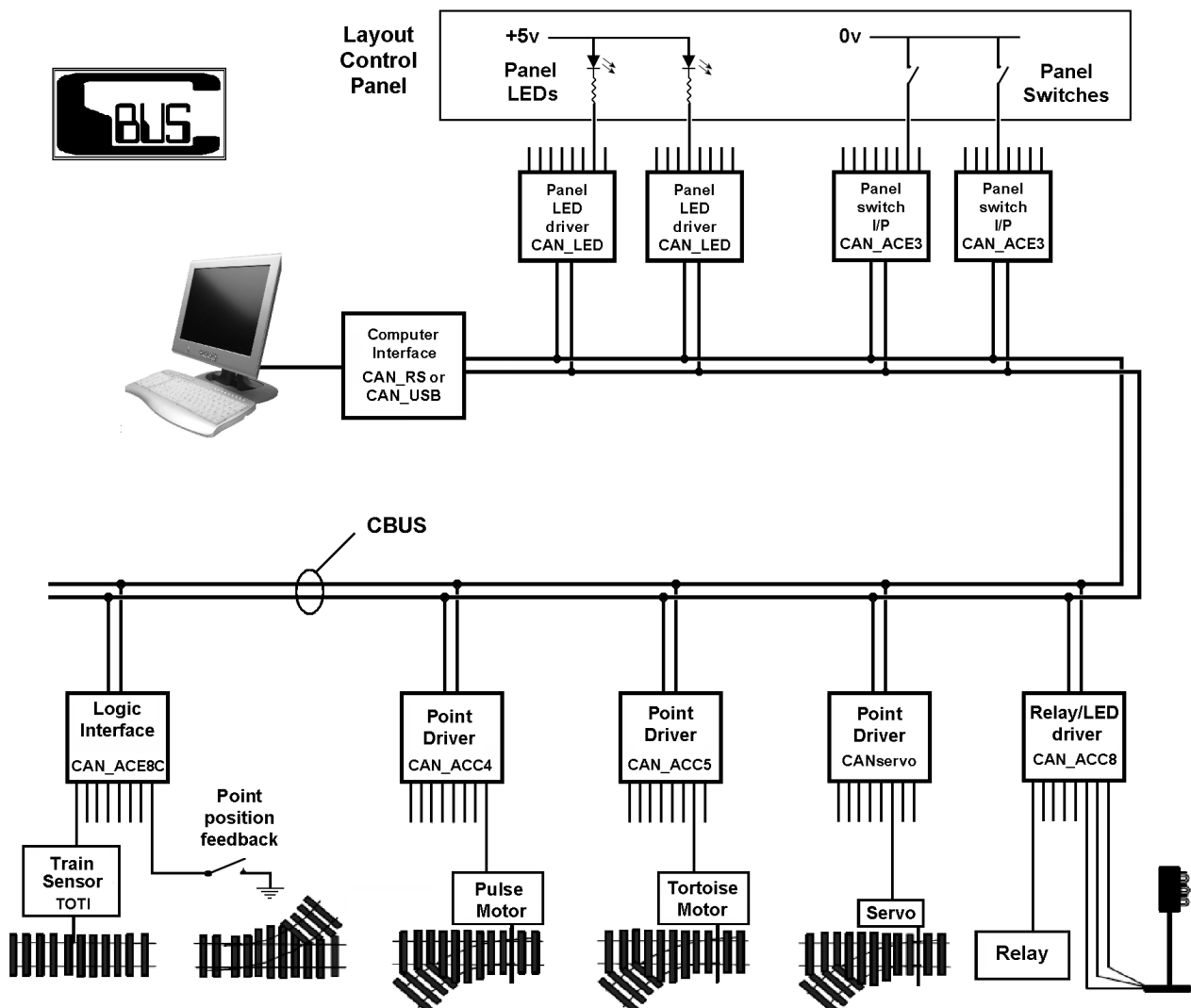
What we need, then, is an accessory system that combines the benefits of a 2-wire system with true 2-way communication, the ability to use mimic panels, the ability to have modules talk to each other over the two wires without using any central intelligence, and the ability to provide all this with or without the use of a computer.

This is what the CBUS system offers – plus more.

The CBUS way

Imagine building a new layout consisting of four baseboards. With CBUS all you need do is run four wires the length of the layout – two for power and two for the control system. No matter how many switches, button, lights, points, track occupancy detectors, accessories, etc. you now add to the layout, you still only need those four wires. The accessory connections between boards are always just these four wires – not the scores of wires associated with conventional wiring.

Like DCC, all accessories are linked via messages. These messages can be transmitted by small modules that can be fitted anywhere on the layout. Indeed, you can have multiple control panels if you like. You could have a mimic panel for a main station, one for a goods yard, and so on. Or, if you prefer, you can control the entire layout from a single panel. A message could be an instruction from a control panel switch to a point motor controller, telling it to switch the point. A message could be from a track occupancy detector to a light on a control panel, informing that a siding or loop is occupied.



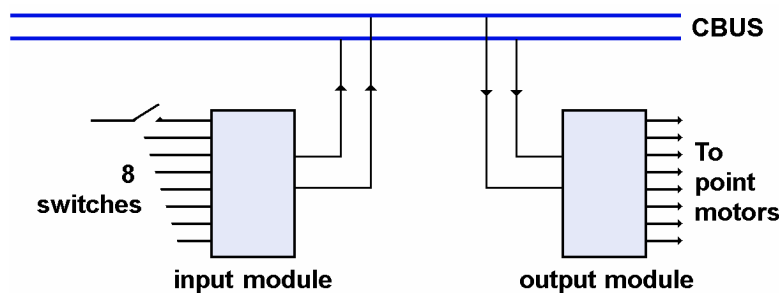
This diagram shows some of the range of options that are provided for by the CBUS system. Some of them give instructions, like the panel switches or the train sensors. Others act on these instructions, like the range of point motor controllers, lights, relays, etc.

All these modules and more are produced as kits by MERG and others, and you can choose which ones best meet your needs.

Lets look again at our imaginary four-board layout which is currently empty apart from a power bus and a two-wire control bus – both running the length of the layout.

If we lay track for a goods yard on one of the boards, we can install a CBUS output module to control their points. The module is connected to the nearest point on the 2-wire bus, to its power supply and to the point motors. This is called a '*consumer*' module since it cannot create any messages. It can only act on incoming messages.

To control the points, we need an input module that can send the instructions to the points module. The input module is called a '*producer*' module since it creates messages when its switch inputs are altered. Like the output module, it connects to its power supply and to the nearest point on the CBUS. It uses a set of switches as inputs (ideal for a control panel). This illustration shows a basic minimum setup for a CBUS system.



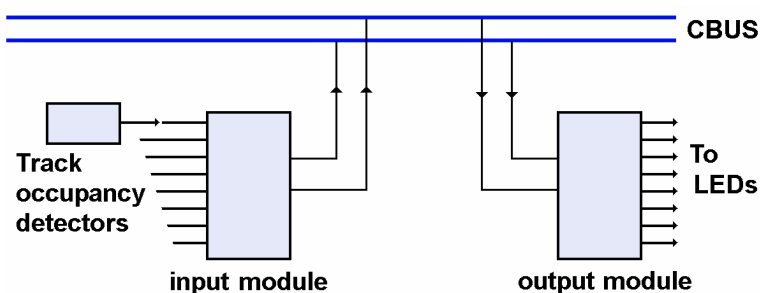
When you throw a switch, the input module recognises the change and sends a message on to the CBUS wires. It is picked up by the output module which translates it into a change of output on the corresponding pin. So, for example, throwing a switch on the input module's pin 3 might result in moving the point motor that is attached to pin 5 (or whatever pin you choose) of the output module .

Two relatively inexpensive modules allow 8 switches to control 8 points.

The modules could be at opposite end of our layout, since they can connect anywhere along the CBUS wiring.

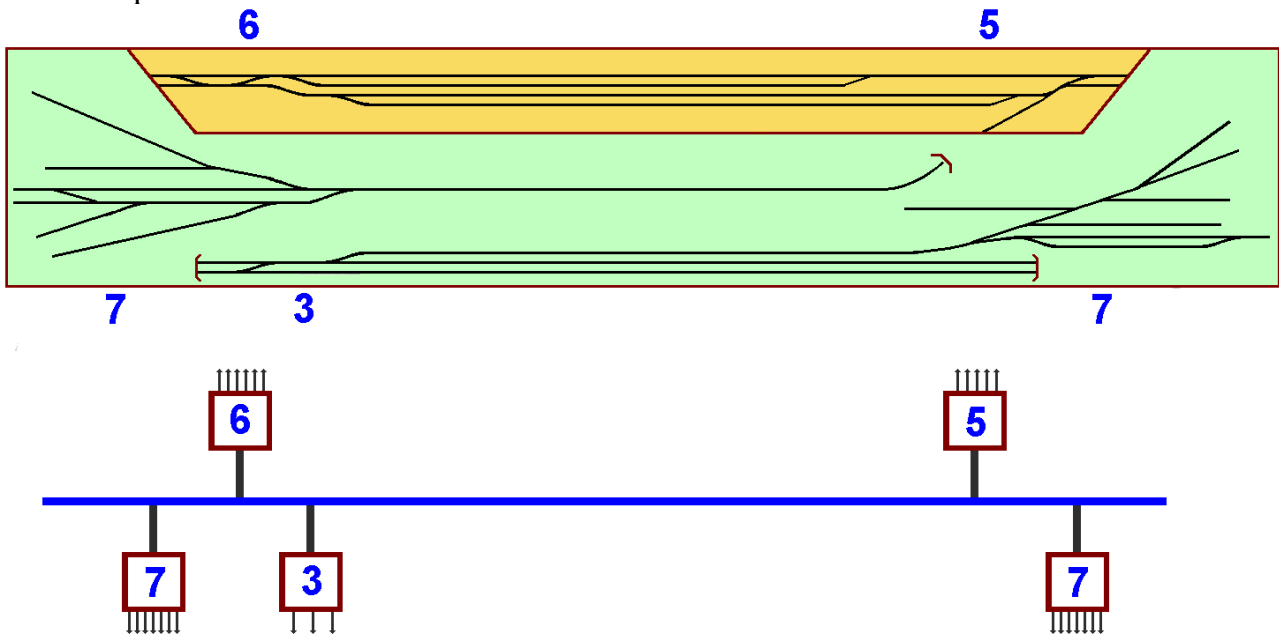
As we extend our layout, we can add more switch modules and more point modules as before. We could have 50 or 100 switches on a control panel operating 50 or 100 points – and all using the same two CBUS wires!

Another benefit of CBUS is the ability to get feedback from the layout. This illustration shows an input module whose input pins are connected to track occupancy detectors. When a train enters that section of track, an input pin's voltage is altered and this results in a message being sent out onto the bus. On the control panel, this message is received by the output module which illuminates the corresponding LED on the mimic panel.



Example layout

Here is an example of implementing CBUS on a typical layout. The layout has 28 servo-operated points and is spread over several boards to allow long rural stretches of track. The points are in four distinct groups. The fiddle yard has 6 points at one end and 5 at the other end. Each station has 7 points and there is a small group of 3 points on the main line. The lower illustration shows how the points could be operated by five CBUS output modules (a typical output module having 8 outputs). Since the points on the left side of the layout are fairly closely bunched, you could even use two 8-output modules at that end.



If we were to examine the underside of this layout's baseboard, we would only see the loco's power bus, layout power and the CBUS wiring. Four (or five) boards would be positioned close to the groups of points.

If we decided to add extra points or features to the middle section of the layout at a later date, we would only need to add another module to the CBUS.

The layout would also have a control panel attached to the same CBUS. It would contain the switches and the modules that send out the control instructions to the board's output modules. The panel can look and operate like a conventional 'hard wired' system.

Advantages of CBUS

The many advantages of CBUS include:

- A big reduction in wiring and connectors, with all the accessory modules sharing the same power bus and the same 2-wire control bus.
- Fewer faults. With far fewer wires and connections (e.g. no multiple plugs between boards), there is much less to go wrong.
- It supports feedback. You can get confirmation that points have moved, tracks are occupied, etc.
- It is easier to make changes and additions. Adding that extra railway station or goods yard requires no baseboard wiring changes. Just add the modules to the existing power and CBUS wires.
- It is suitable for automation / computer control.

Different levels of use

While CBUS offers a comprehensive range of facilities, you can use as much or as little of it as you need. If you already have a fully functioning layout, you may want to use CBUS output modules to add additional features. If you are planning a new layout, you may decide to use a full implementation of CBUS across the entire layout. It is up to you.

Here are some suggestions for different levels of implementation:

- Output modules to switch on lights in buildings.
- Output modules to operate signals.
- Output modules to operate animations (e.g. cranes, level crossings).
- Feedback from track detectors to indicate occupation of hidden sidings.
- Control of point motors.
- Control of locos (CBUS includes modules to control DCC locos).
- Computer automation of layout (including the use of track detectors or RFID).

The first four suggestions can be added to any existing layout without any changes to its existing wiring and control systems.

What is CBUS

CBUS is based on the widely used CAN Bus (Controller Area Network) system, adapted for use with model railways.

The CAN bus (sometimes described as Cbus or C-Bus) was developed for cars in the 80's and found its way into many industrial, medical and military pieces of equipment.

Everything from a coffee machine to the Las Vegas monorail works using the CAN bus, not forgetting Otis elevators, fork lifts, radar stations, drones and CERN.

The CAN bus, with tens of millions of controllers sold each year, is a tried and tested system. It is robust, reliable and resistant to external interference. After all, you would expect nothing less from a chip that is controlling aircraft, cars, lifts and medical equipment. Due its widespread use, the main interface chip is easily available and is cheap.

CBUS (all in capital letters) is based on the industry standard CAN bus, using its interface chips and basic principles. In addition, it gives special consideration to how it can aid model railway hobbyists.

Benefits of CBUS

- Low cost.
- Not tied to any manufacturer.
- Works with any scale or gauge.
- Works with DC or DCC layouts (although loco control is DCC only).
- Works with both small home layouts and large club layouts.
- Operates on wiring lengths of up to 500 metres, enough for all but the most ambitious garden layouts.
- Provides manual, semi-automatic or automatic control of devices (see later).
- Can be used on new layouts or integrated into existing layouts.
- Available as a range of self-build kits, with all parts and construction notes supplied.
- Module construction only needs basic soldering skills.
- Easily set up. No programming skills required (additional modules are available for those who wish to have computer control of their layout).
- Lots of support from other users.

The CBUS cable

The pair of wires that carry the messages throughout the layout should be '*unshielded twisted pair*'. This simply means that the two wires should be twisted round each other to prevent unwanted interference. There is no need to buy shielded cables that have foil covering. In fact, you can make your own cable from any wires as long as they are loosely twisted together as shown in the image. Since the wires only carry messages, there is no need to use heavy gauge wires. The speed of the system dictates that the maximum length of the bus is 500m, so it can handle very large layouts.



The bus has to be '*terminated*'. This involves fitting a resistor across the two wires. Without this, there is a danger that signals will reach the end of the cable and reflect back down the wire, interfering with the wanted signals. Depending on your age, you may remember seeing 'ghosting' on your TV picture, which is an identical phenomenon. Fitting a resistor allows for the signal to be absorbed and prevents reflected electromagnetic waves from distorting the messages. The resistor is also required for proper CAN arbitration to work (i.e. preventing two producer modules from sending messages at the same time). A 68 ohm resistor is fine for small cable runs; for most layouts, fit a 120 ohm resistor at each end of the bus.

The bus wires should run the length of the layout. It need not run in a straight line; it can snake along to go where it is needed. Stubs are allowed; these are short stretches of cable that run off from the main bus (e.g. to feed a board in a T-shaped layout). Stubs should not exceed 3m in length.

Connecting the modules

Adding a CBUS module to a layout consists of a few steps:

- Connect the module to its power supply.
- Connect the module to the CBUS cable.
- Connect the inputs (e.g. from track occupancy detectors) or outputs (e.g. to point controllers, lights, etc.)
- Configure the module the way you want it to operate (see later).

The connections can be soldered, or use connectors. Plugs and sockets can be used to allow the quick replacement of a faulty unit (handy at exhibitions).

Once connected to the CBUS network, modules can be used in various configuration:

- Between the layout's modules and a control panel.
- Within the layout (e.g. the arrival at a station brings on the station lights)
- Between baseboard panels (e.g. providing communication between multiple operators)
- Between the layout and a computer.

You can use one of these, or all of them, depending what you want to do.

Expandability

At its simplest, a layout using CBUS need only have one module that sends commands and one module that acts on the commands.

However, the CBUS was devised to allow for huge expansion potential.

You can fit an unlimited number of consumer modules, if they are used in SLiM mode (more later). Producer modules are limited to 110 nodes (the CBUS name for a producer module) on a single segment (an unbroken stretch of CBUS cable). Since some modules can handle 64 inputs and some can handle 64 outputs, a single segment can handle 3520 inputs and 3520 outputs. If that is still not enough, you can connect different segments

using a bridge module, until you reach a maximum of 65,536 nodes on the system! Depending on how they are configured, each node can produce up to 65,536 'events' (different instructions). So, the system can handle 4.29 billion different instructions!

How CBUS works

Some CBUS modules either send messages or receive messages, and some modules can both send and receive.

Some modules only ever send messages on to the bus. They are called '*producers*' since they produce messages when activated. An example might be a module connected to track occupancy detectors. This small board may have inputs from, say, eight track occupancy detectors. The message sent by the module would depend upon which change is detected. An even simpler example might be a bank of off/on switches used to control points, signals, trackside lights etc. The group of switches could be held in a frame or could be mounted on a mimic board/control panel. Throwing a switch produces a message that uniquely identifies which switch was thrown on that input module and whether it was switched on or off. In these examples, changing one of eight inputs to a module results in one of sixteen unique messages being transmitted on the bus (one message when an input goes high and a separate message when that input goes low).

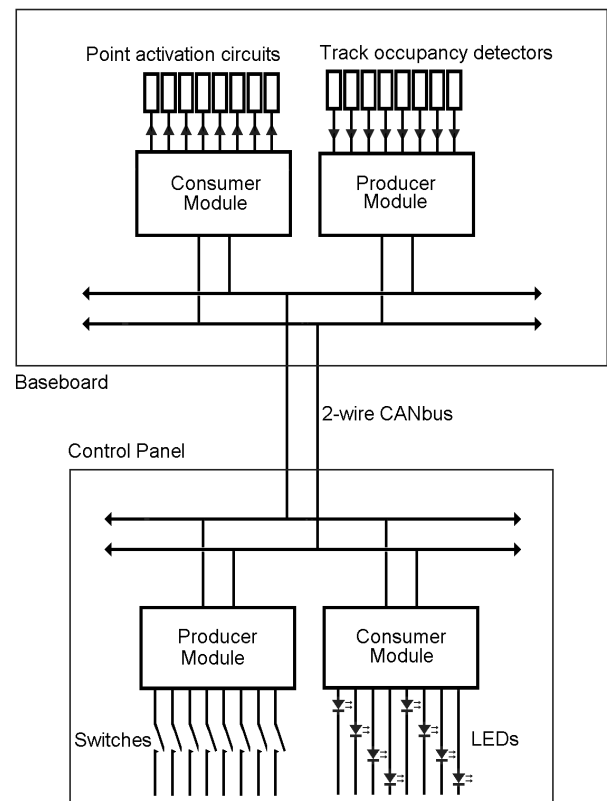
Other modules are designed to only ever receive messages and to act upon them. These are called '*consumer*' modules and examples include point actuation and LEDs on mimic boards. So, for example, a message received by a module might result in one of its output lines being switched on or off. These output lines can be used to switch eight different point motors. Another module can light up to 64 different LEDs depending upon the input messages received.

The user does not need to know how the message is constructed and how it works in order to use the system. The user simply throws a few setup switches and the module's electronics take care of everything.

A small example

The diagram shows a simple setup, with a baseboard that has eight points and eight track occupancy detectors. The control panel has eight point switches and eight LEDs. Along with power connections, the CBUS links the control panel and baseboard and carries messages between them. The baseboard modules are connected to the user's point activation units and track occupancy detectors.

Assuming that the four modules have already been set up (see later) their operation is straightforward. So, if a train activates track detector number 5, the producer module sends out a unique message on the bus.



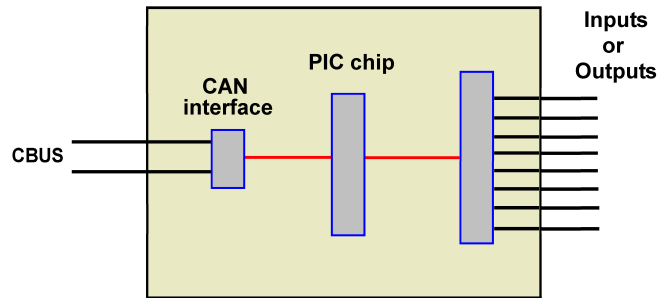
The consumer module on the control panel translates that message into switching on LED number 5. Similarly, throwing point switch 3 makes that producer module transmit a unique message over the bus that results in point number 3 being activated.

CBUS Modules

Most CBUS modules use the same basic arrangement shown in this illustration.

It has three main parts:

1. The CBUS module's interface between the bus and the controller chip. This is known as a '*CAN transceiver*'. Every CBUS module needs one of these so that it can send to, or receive messages from, other modules connected to the bus.
- A PIC chip, which is like a small computer that stores a program and data. Its contents are programmable so that it has multiple possible uses, depending on what the module is used for. This is the 'brains' of the module.
- The Input/Output, which is the connection to the hardware devices. A producer module, for instance, might have switch inputs, while a consumer module may have outputs for controlling point motors.



Users are constantly developing new modules, and providing new features to existing modules. Using PICs is a benefit, as the program built into it can be updated; there is no need to throw away a module when an improved version comes out.

Let us look at the range of CBUS modules that are available from MERG.

Eight input module

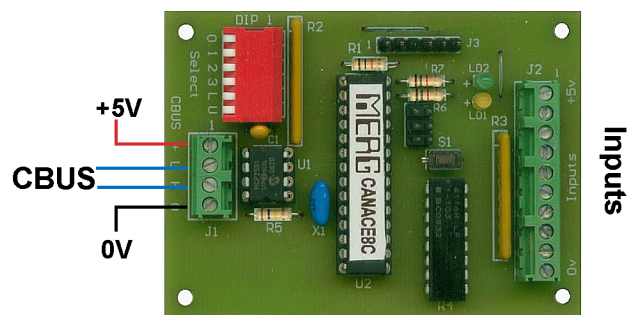
This is known as the **CAN-ACE8C** and it operates from 5V DC.

It has eight input connections. Each connection is normally held to +5V internally.

Bringing that connection down to its 0V line results in a message being sent out on the CBUS. Removing the 0V lets the connection revert back to +5V and this results in a different message being sent on to the CBUS. So, the module can produce two different messages for each connection – one when a connection is at +5V and one when it is at 0V.

Any device that can switch between a high and 0V voltage can be used as an input. The most common inputs are toggle switches, microswitches and track occupancy detectors, although other electronic modules could also act as inputs.

If this module is mounted in a small control panel (e.g. to control a small layout or a small local goods yard in a larger layout), it would use switches to control points/lights on the layout. If the module is mounted under the baseboard, it could be used to send back information to a control panel, that a track section is occupied or to indicate the direction a point is facing.



Eight output module

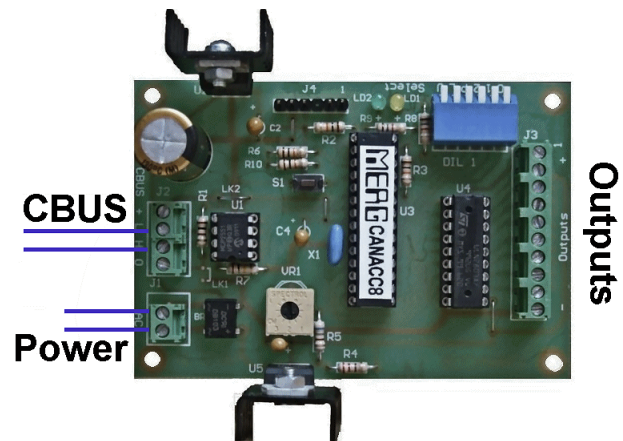
This is known as the **CANACC8** and it operates from 16V AC, although it can be converted to work from 12V DC.

Apart from the connections for power and the CBUS cable, there are eight outputs that can be switched between 0v and anywhere from +5v and +15V (or up to +12V if converted).

The little white square is actually a preset potentiometer that sets the voltage.

Being able to vary the output voltage means that it can switch 5V relays or 12V relays, LEDs, lamps and even small DC motors.

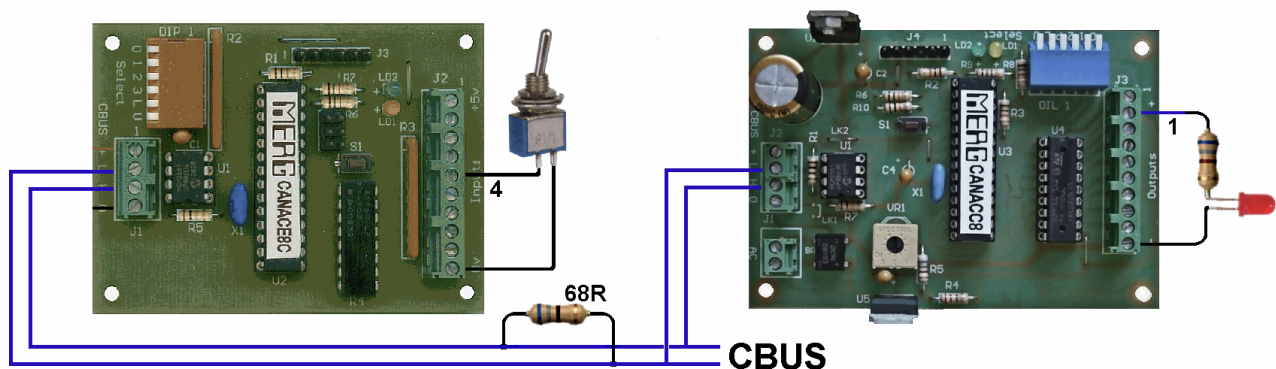
Each output can handle a maximum current of 500mA, although the sum of all outputs must not exceed 1A. It is commonly used to control lights, relays and point controllers (such as servo controllers for crossing gates, semaphore signals, etc.) The outputs can operate relays to switch point frogs. Also used to remotely switch lights in buildings.



Simple example

This image shows how to connect a single input module (the CANACE8C) to a single output module (the CANACC8), so that throwing a switch controls the LED.

For simplicity, it does not show the power connections.



The points to note are:

- The CBUS has CANH and CANL wires, marked H and L on the modules. The H connection on a module should be taken to the H wire of the bus; similarly, the L connection on all CBUS modules should be taken to the L wire of the CBUS.
- A terminating resistor of 68 ohms has been wired across the CBUS.
- The variable resistor has been adjusted to produce a +5V output.
- The switch is connected to input 4 of the input module, while the LED is connected to output 1 of the output module. Input 1 does not have to control output 1 and so on. You can decide which output will be switched by any particular input.

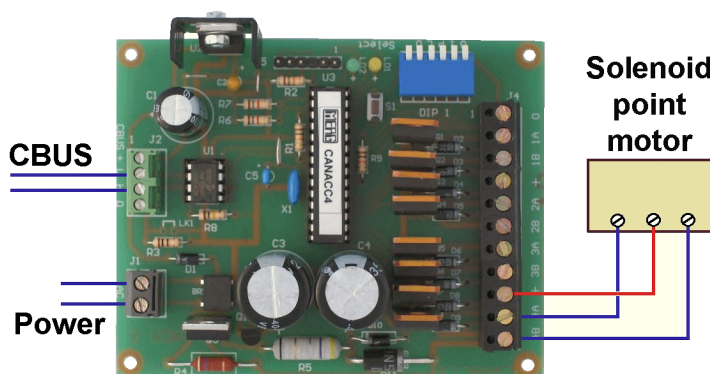
Controlling four solenoids

This module is known as the **CANACC4** and it requires a 16V AC supply.

It is specifically designed to handle four solenoid-type point motors, such as the Hornby, Peco, Atlas or Seep type.

The module has a capacitive discharge unit (CDU) built in to the board and connects directly to the point motors as shown in the illustration.

Each point is allocated two messages – one to operate the point in one direction and another to operate the point in the opposite direction.



This is the **CANSOL** and it operates on a 12V DC supply.

It also handles four solenoid point motors with its built-in capacitive discharge unit and operates in the same manner as the CAN-ACC4.



Controlling four point motors

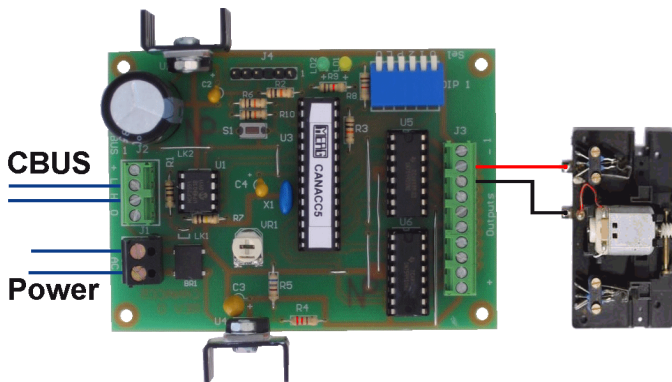
This module is known as the **CANACC5** and it operates from 16V AC, although it can be converted to work from 12V DC.

It is specifically designed to handle four motorised point motors, such as the Tortoise, Hoffman or Conrad types.

The illustration shows a Fulgurex point motor being connected – although not to scale.

The module's outputs consist of four sets of two connections. Each point is allocated two messages – one to place a

voltage across the two connection (e.g. as in the illustration) and another to reverse the polarity of the connections. Alternatively, it can be configured as eight separate outputs to operate light signal lamps etc.



Note

The three output modules shown above can be controlled by using two unique messages for each output.

If you wish, you can have several, or all, of the outputs controlled by the same pair of messages. This is useful for route switching, where one command can move a set of points and another command resets the route.

Mimic panel modules

The eight input and eight output modules are ideal for mounting under baseboards, to operate points and send back feedback. The benefit of the CBUS system is having small local modules where you need them rather than having wires trailing all over your layout. They are not very useful, however, when used on a control panel or mimic panel, unless you have a very small layout or are using a number of small controls panels spread across the layout.

For large panels, there is a need for modules that can handle larger numbers of switches or LEDs.

Consider, for example, having a control panel with 50 switches and 50 LEDs. You would need 7 input modules and 7 output modules built into the panel- which would be very cumbersome.

So, MERG has a couple of modules that are specifically for use in control panels.

This module is known as the **CANACE3** and it operates from 16V AC, although it can be converted to work from 12V DC.

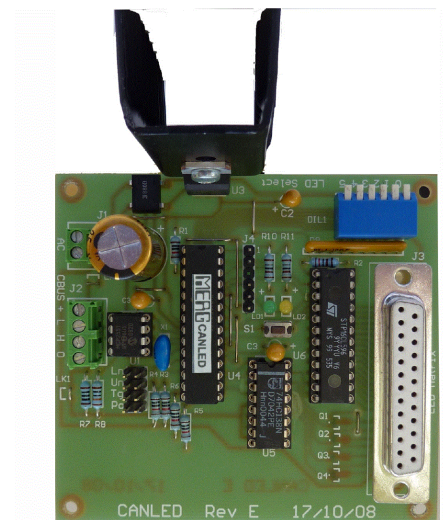
It has a switch interface that can handle 128 toggle switches or 64 pairs of push buttons.



This module is the **CANLED**. It can handle 64 LEDs.

Using just one **CANACE3** and one **CANLED** in a control panel, you can control up to 64 points/accessories and indicate feedback from 64 devices.

The large sockets on the right of each module are provided for the connections to the switches/pushbuttons/LEDs.

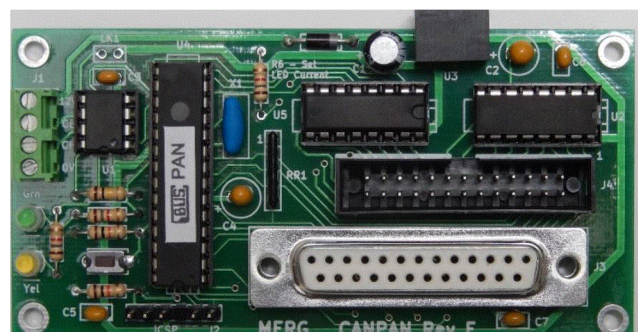


Combination modules

These combine consumer and producer functions on the one module. They have inputs for switches, etc. and also outputs for relays, LEDs, etc.

An example is the **CANPAN** module. It is useful for smaller layouts (those with fewer than 32 switches and 32 LEDs).

It operates on a 12V supply and combines the functions of the **CANACE3** and **CANLED** modules on the one module board.

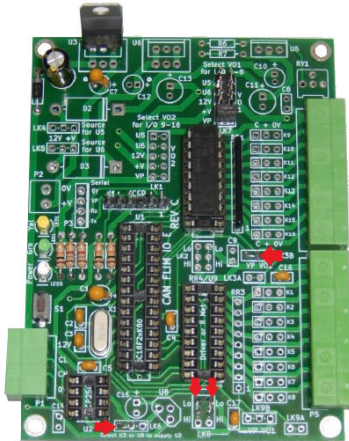
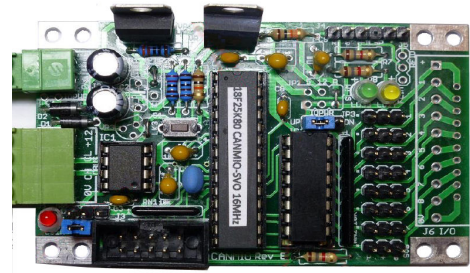


Combi with servos

There is also a demand to be able to control servos for points, signals, gates, animations, etc.

The **CANMIO-SVO** module is designed for that purpose. It operates at 12V and handles up to 8 servos with the option to have 8 digital inputs.

Servos plug directly into the row of three pin plugs. The digital inputs could be used to provide feedback from microswitches on a point's tie bar (specially useful for automated systems).



The move to combi modules now provides a **CANVOUT** module.

This module uses a 12V and is like **CANACC8** and **CANACE8C** modules combined.

It provides 8 digital outputs and 8 digital inputs

Computer Interface

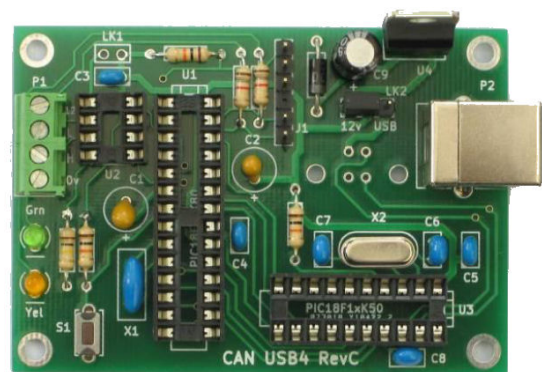
The CBUS modules were initially able to be set up and used without the need for a computer and some still provide that option. More recent modules require a computer to configure them.

MERG has a kit known as the **CANUSB4**.

It connects to the CBUS and plugs into a USB port on your computer.

With appropriate software, it can provide useful new facilities such as:

- Testing CBUS modules, to confirm whether they are functioning correctly. You can send messages on to the CBUS from the computer and see whether an output module responds as it should,.
Alternatively, you can check an input module by examining its messages on the computer screen.
- Controlling a layout. Using computer software (covered in the chapter on '*Using Computers*'), you can operate points, accessories and even trains from a computer screen, using your mouse or by writing scripts.
- Setting up your modules, using the free configuration software for MERG members.



DCC Command Station

For many, the benefits of CBUS lie in controlling points and accessories, or getting feedback from track detectors, etc.

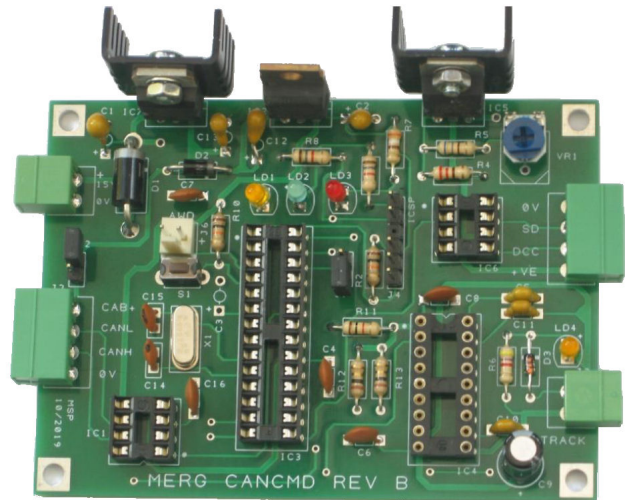
For DCC users, the CBUS system extends into controlling locos using a couple of modules.

The image on the right shows the **CANCMD2** module which is a complete DCC command station.

It has connections for power, the CBUS and the layout track (either directly or through a power booster).

It can be controlled via the CBUS in either of two ways:

- Using a handheld controller.
- Using computer software



For those who like to walk round their layout while controlling their trains, MERG have a **CANCAB** module, as shown in this image.

The module connects to the CANCAB with a cable.

Pressing the buttons, or turning the speed knob, results in instructions being sent to the command station which are translated into control messages for the layout's locos.

Other CBUS modules are available from MERG (e.g. the CANACT, CANPiZero, CANPiCAP) – and more are in development. The CBUS system is constantly evolving with new boards being added that offer even more features and greater flexibility.

Conclusion

The CBUS system is very versatile and covers many different needs through its variety of modules.

The bus can be as long as 500m and with a data rate of 125kbps can easily handle the operations of many modules

CBUS messages

We don't need to know the content of a message in order to use the system but here is a simplified description.

Consider the example of a switch controlling a LED.

The message that would be sent would include the following

opcode nodenumber event

where

opcode is the type of command included in the message

nodenumber describes which module (node) initiated the new message

event describes what has changed

At the sending (i.e. producer) end

- A message is sent when something *changes* in an input module – e.g. a switch has been thrown. CBUS calls this an '*event*'
- The message contains information on *which* pin has changed – e.g. pin 4 in our example.
- The message contains information on *how* it has changed – e.g. it has been changed to a high or a low voltage.

So part of the message sent on to the bus includes one of the following:

"The fourth input connection has changed to low"

In reality, the message so far would contain this:

91 0004 (*91 is the 'Op Code' for Accessory Off*)

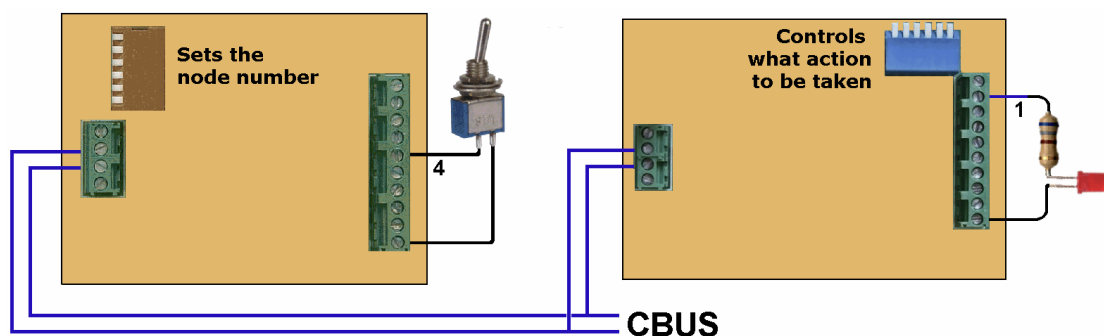
or

"The fourth input connection has changed to high"

90 0004 (*90 is the Op Code for Accessory On*)

So far, so good. But a system might have several producer modules and each one of them will have a input connection number 4. If all the producer modules sent out the same message, output modules would not know which one they were supposed to act upon.

The message, therefore, also has to contain information about *which module* is sending the message. This is achieved by giving each producer module its own unique number, known as a '*node number*'.



Consider the example in this diagram, if the producer module with the switch attached was given a node number of 7. Throwing switch 4 from high to low would produce a message with the following essential information:

"Node 7's fourth input connection has changed to low"

This actual message would include this:

91 0007 0004

Inside every message there is information on what has changed and what module sent the message.

On the bus

When an event occurs in a producer module, it sends out a message without knowing whether any consumer module will respond to it. It just sends the message anyway. This is known as '*fire and forget*'. The producer module does not check for any acknowledgement that its message has been received by another module.

There are a number of possible situations.

- There may not even be any consumer modules attached to the bus. The messages are being sent but no-one is listening.
- There may be many consumer modules attached to bus. They will all receive the message but none may be set up to act on the message.
- A single module may receive the message and act upon it.
- Several modules may receive and act on the same message.

CBUS messaging is not equivalent to sending a text message to a particular friend, where that person's phone is the only one to receive the message. It is more like the Saturday night Lottery broadcast. The results of the draw are broadcast to all who want to listen but only a few will act on the message.

In our earlier example, an event was created when node 7 had its pin changed to a low state. It is up to the user to decide which consumer module will respond to that message and what action it will take as a consequence.

At the receiving (i.e. consumer) end

Since all producer modules have their distinctive node numbers, we can now distinguish between messages. We may know, for example, that all the messages from node 5 come from track occupancy detectors, while messages from nodes 4 and 6 come from switch panels, and so on.

In such a case, we could use an output module to drive panel lights when it receives messages from node 5, while using an output module for driving points motors when messages are received from nodes 4 and switching lights in buildings when messages are received from node 6.

The next step is to decide what each module should do, if anything, with an incoming message. You have a lot of flexibility in how you configure your output modules. This is achieved in many modules using the bank of switches, while others have to be configured using a computer.

The options include:

- Ignoring a message. This will be the most common reaction, since most messages are of no interest to the majority of consumer modules.
- A consumer module's outputs all being dedicated to the same type of outputs – all LEDS or all point motors.
- A consumer module (e.g. the 8 outputs of the CAN-ACC8) being used various purposes – some connections switching lights, others switching relays or point motors.
- Different outputs of a consumer module being activated by the *same* message. This allows a single switch on a control panel to change a group of outputs – very useful for setting up routes and signal aspects.

Setting up modules

For a basic 8-input producer module, the only setup needed is allocating a node number to the module. At its simplest, you can throw a couple of switches and the job is done. CBUS modules can be set up using switches or using a computer, depending on the module. Once set up, a module acts in exactly the same way, regardless of what was used to configure it.

It is just two different ways to achieve the same end. Modules set up by switches and modules set up by computer can be used happily on the same layout.

SLiM

The default mode is called '*SLiM*' (The Small Layout Model).

This method has the following advantages:

- It allows modules to be set up using switches – no computer is required.
- Modules can be configured and tested before fitting under the baseboard.

It also has a few disadvantages:

- The setup process can be fiddly and error-prone, unless you really concentrate.
- You have to carefully document what outputs are changed by which inputs, otherwise it will cause serious inconvenience if you have to make changes later.
- Replacing a faulty board is more time-consuming than with FLiM.
- Reconfiguring the module means fiddling with switches while perched under a baseboard, or removing the module for alteration.

The exact method of configuring SLiM CBUS modules is documented in each kit's instructions.

There are also excellent articles that cover practical implementations of CBUS.

For further reading on this, see

 "*Experiments with CBUS*" by Howard Watkins

 (MERG Journals for Spring, Summer, Autumn Winter 2008 and Spring 2009)

 "*A Starter CBUS Project*" by Davy Dick

 (MERG Journals for Summer, Autumn and Winter 2009).

FLiM

The method using a computer for configuring modules is called '*FLiM*' mode (The Full Layout Model). This method has the following advantages:

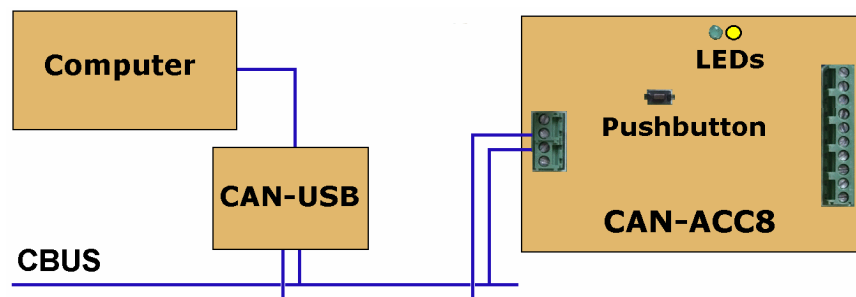
- You just fit and wire the modules, then all configuration takes place while sitting in front of your computer.
- The configuration software maintains a database of all the modules, what triggers them and what their outputs do. No need to keep paper records.
- Changes in your layout track plan or points routing are easily dealt with as the software updates all the changed relationships for you.
- It is quick and easy to replace a faulty module. Plug in the replacement module then download the previous module's settings into it from the database.
- Complicated configurations, such as the CAN-ACE3 and the CAN-LED are easier to accomplish using software.

FLiM also has a few prerequisites:

- It needs a computer with Windows 7 and above.
- It needs a CAN-USB module.
- The configuration process takes a bit of getting used to.

The FLiM setup

The illustration shows the setup for configuring modules.



A CBUS-to-computer interface module, the CANUSB4, is plugged into the USB port of a computer and connected to the CBUS cable.

The module to be configured is connected to the CBUS and to its power supply.

A consumer module that can be switched between SLiM and FLiM modes, is switched by holding down the pushbutton for about 8 seconds, until the yellow LED illuminates (indicating FLiM mode) or the green LED illuminates (indicating SLiM mode).

The computer should have a software utility, called the FCU (FLiM Configuration Utility) installed on it. The utility creates and maintains a '*configuration file*' which stores the configuration details for all CBUS modules on the layout's bus.

Unlike SLiM, which only allocated node numbers to producer modules, every module is allocated a node number in FLiM mode. This is necessary so that the utility can identify individual consumer modules for configuration.

When many modules are connected to a layout, giving meaningful names to all the producer modules and their events, plus all the modules and their outputs, makes later identification and understanding much easier.

There is an excellent Guide, written by the utility's author Roger Healey, which explains the process in great detail.

You only use the computer during the setting up operation, or any subsequent additions or alterations. It does not need to be permanently connected, unless you decide to automate, or semi-automate your layout with other control software.

Notes

This chapter only provides an overview of the basics of CBUS.

CBUS is extensively covered in MERG's Technical Bulletins (there are currently 17 different Technical Bulletins in the MERG website).

The KitLocker section of the website has details of all the CBUS modules it sells (just click on the '**i**' or '**tb**' button for full details).

There are also many practical articles in back copies of the MERG Journal.

On the MERG website, there is a '*MERG Wiki*' section.

In the '*Layout Control Buses*' section you will over 30 links to material on CBUS.

