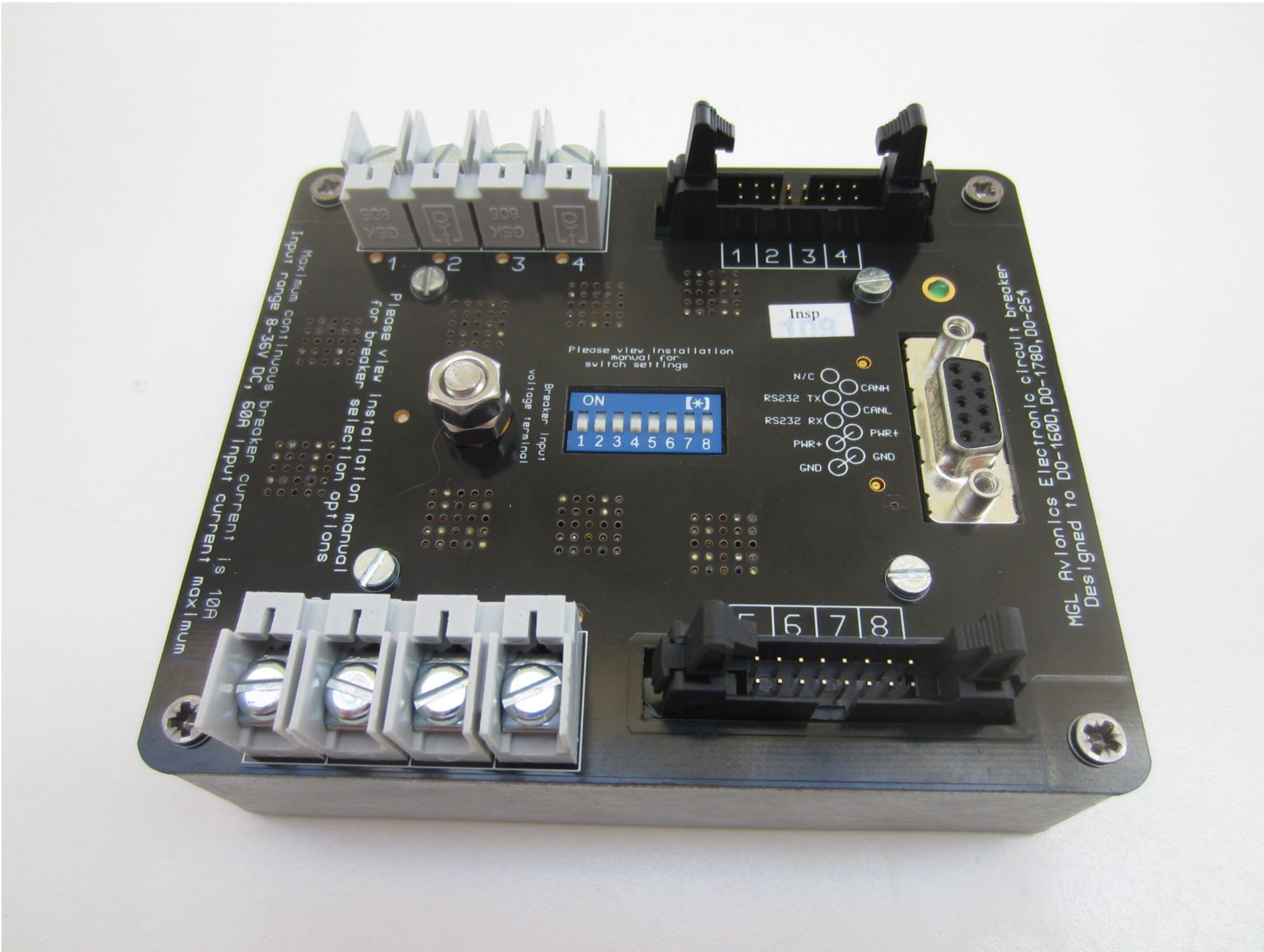
MGL Electronic circuit breaker module



User and installation manual

General

The ECB module provides 8 electronic circuit breakers. All breakers have the same characteristics:

DC current up to 10A (programmable via dipswitch profile selection) or via an external device.

Suitable for 12V or 24V DC aircraft power systems.

Highly reliable, fault tolerant design – continues to operate even in case of total internal electronics failure.

Can be used as a stand-alone device or it can be connected to an EFIS system.

In case of connection to an EFIS system, EFIS can show individual DC currents through each breaker, breaker states and in case this is allowed via dipswitch selection, the EFIS may also control breakers.

EFIS can setup breaker trip currents in 0.1A steps up to10A as well as trip reaction times in steps of 0.01 seconds. Trip reaction times are further modulated by the amount of overcurrent (I.e. Times are shorter the higher the current above the trip limit).

Breakers may be paired or tripled to create breakers of 20A or 30A capability.

Very high quality semiconductor switches are used offering very low on-resistance and consequent low self heating. Further to this switches are protected against reverse polarity, ultimate over-current and over-temperature conditions.

Each breaker output is available on a screw terminal and features a built in LED indicator connected to the breaker output. Further to this a stainless steel M6 bolt is provided as input power terminal. This terminal also has a built in LED connected to it to show availability of power.

Breakers are controlled via low current, low voltage latching switches and/or via an external device such as an EFIS.

Each breaker offers two status outputs intended for panel mount or switch mount LEDs. These are typically used for red and green LEDs or dual color red/green LEDs. The green LED shows the switch status (on/off) while the red LED shows the breaker fault status.

It is also possible to use just a single LED such as is used with many attractive panel mount switches. In this case the LED will be solid ON if the breaker is on and will flash if the breaker is switched on but tripped (faulted). The LED is off if the breaker is switched off.

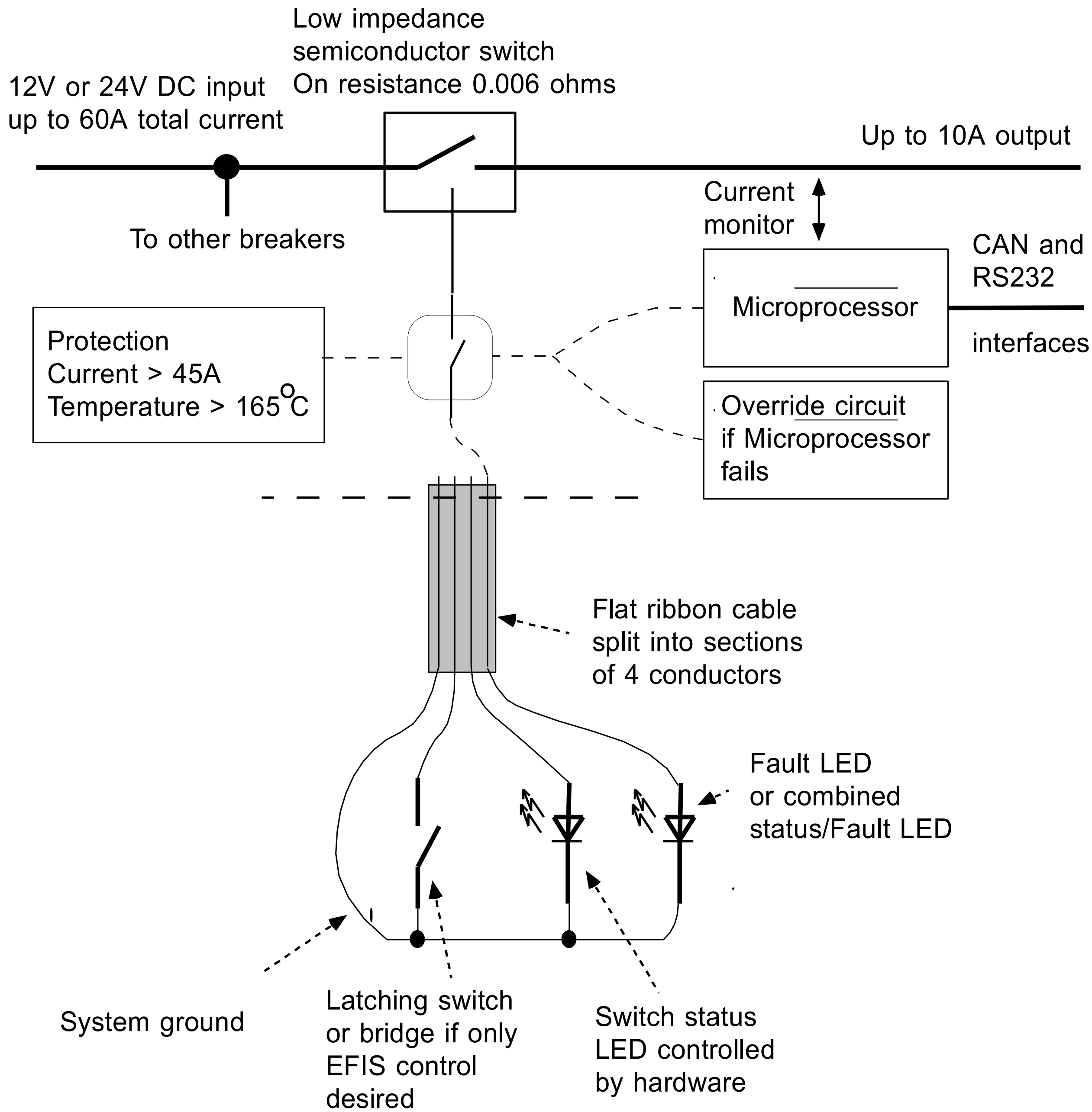
Several profiles are available to support typical landing light “WigWag”. In this mode a landing light has two breakers (or four with breaker doubling), one for the left and one for the right wing. The breakers have three operational states: Both off, alternating on/off and both on.

The “WigWag” function is a particularly effective way of increasing visibility of small aircraft under way at large airports where a multitude of lights may obscure these craft.

A LED flasher profile is available which uses two breakers to create bursts of three short flashes on each breaker. The breakers are phased such that none of the two breakers are on at the same time. This mode allows direct driving of high brightness 12V LED lamps to replace strobes etc.

The breaker in detail

This image shows a block diagram of each of the 8 equivalent breakers in the system.



The LEDs

The left LED reflects the status of the switch. Normally a green LED is used for this. This LED may be omitted and only the Fault LED used. In this case please reprogram the unit (either via dipswitch or via EFIS) to use a single LED. In this case use a green or blue LED connected to the Fault LED line and leave the switch status line unconnected.
In single LED mode the Fault LED will flash if the breaker has tripped, otherwise it will be either on or off to reflect the state of the switch.

The Override circuit

The override circuit monitors the microprocessor. If the microprocessor fails the override circuit takes over within 2 mS and enables the switch.

In the override state the external switch dictates the breaker state and if bridged the breaker will be switched on.

Breaker trip current will be set to 45A. The breaker will also trip if the internal temperature of the breaker reaches 165 degrees C.

Notes:

If Landing lights are used with WigWag, in override mode the landing lights will be switched on if the panel switch is on. No Wigwag will take place.

If burst flash is used, the outputs will be on if the panel switch is on. If high power LEDs are used, please ensure they have adequate protection and will not be damaged by permanent power applied.

Power sequencing

On start up of the ECB any breakers that have control inputs grounded ("on" state) will have the actual breaker closure sequenced where breaker 1 switches on first, followed by other breakers in sequence. Interval between breakers is 0.1 second.
This feature limits the start current surge in a typical aircraft system.

Note: In case of breaker override (internal ECB microprocessor not operational) this sequencing cannot happen and all breakers that have their control inputs grounded will switch on at the same time.

Breakers controlled only by external system

If it is desired that breakers are only controlled by an external system, provide a bridge in place of the switch. You can consider bridging the connector itself if no LEDs are needed.
This image shows an example:

Notes: With breaker switches bridged, in case of a microprocessor failure (ECB) all bridged breakers will be "ON". No control from external devices (EFIS systems etc) will be possible in this case. Please consider this in your system design.

Breakers controlled by ECB panel switches and external system

No further action needs to be done in this case. Wire the panel switches as normal to control the breakers. If an external system is connected it can switch breakers provided the panel switch is “on”.

If panel switch is “off”. Breaker is “off” regardless of external control, external switch commands are ignored.

If panel switch is “on”. Breaker is “on” - external system can control breaker (switch on and off once the panel switch is “on”).

Example: Panel switch is “off”. External system sends command “on”. Command is ignored. External system sends command “off”. Command is ignored. Panel switch is switched “on”. Breaker is “on”. External system sends command “off”. Breaker switches “off”.

Breaker doubling and tripling

Certain breakers can be joined to create breakers of greater current capability.

This is selected via dipswitch profile or in case of programmable profile via the EFIS ECB setup.

Choices are:

1+2

1+2 3+4

1+2+3

1+2+3 5+6

In case of programmable profile, trip currents set from EFIS still apply. It is advised that trip currents for joined breakers be set equal. If one breaker in a joined set trips, all breakers in the joined set will trip regardless of each individual breaker current.

Notes:

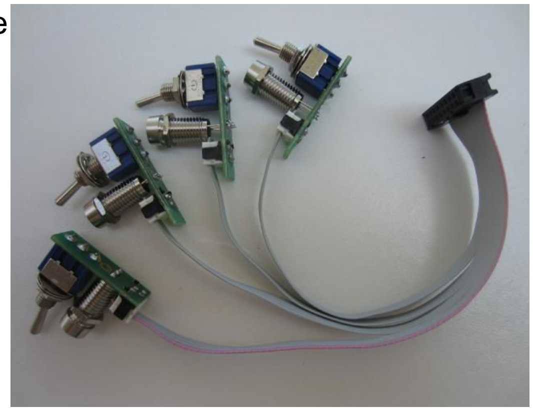
Correct current sharing is desired in case of joined breakers. This means equal length and type of wires connected to joint breakers. You can choose either short stubs joined to a common cable or longer cables (of equal length and type) joined further away as is convenient.

Breaker control inputs for doubling/tripling

Any breakers selected for doubling or tripling must have their breaker control inputs tied together to a common panel switch or tied to ground if only EFIS control is needed.

All LEDs for common breakers will light in the same fashion so if LED indication is required, only one set of LEDs can be used. Leave other LED lines unconnected.

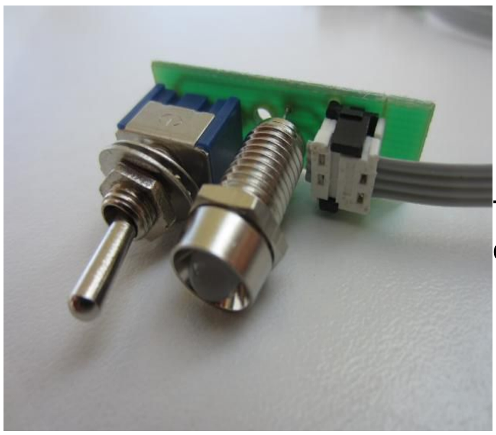
Breaker controls



Many options exist when it comes to selecting suitable breaker control switches and indicators. This image shows a ECB control cable made up with the optional switch kit from MGL Avionics.

The kit consists of PCB, latching toggle switch, dual color (red/green) LED with chromed bezel and a convenient crimp connector allowing simple connection to the ribbon cable to the ECB.

This solution would require two mounting holes in the panel for each breaker.



This image shows one of the switch kit breaker controls in close up.

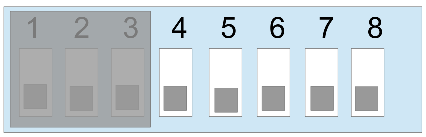
This image shows popular choices for panel mount switches with built in LED lamps. These typically have a single color LED so you would set the ECB into single LED mode using the programming profile or via the EFIS setup menus.

Breaker profiles

5 of the 8 dipswitches are used to set the desired breaker profile. Profiles choose preset trip currents and breaker doubling/tripling as well as WigWag and Burst flash modes.

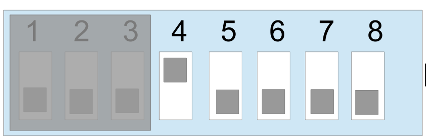
One profile is available for programming (allows to program certain functions without aid of an external device), one profile is reserved as “programmable” profile – in this case an external device can set breaker and ECB parameters (this is usually the mode chosen if an EFIS is used).

Profile 1



Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	10A	10A	10A	10A	10A	10A	10A	10A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

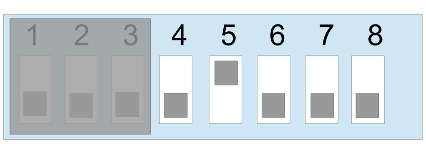
Profile 2



Breakers 1+2 and 3+4 joined = 20A x 2

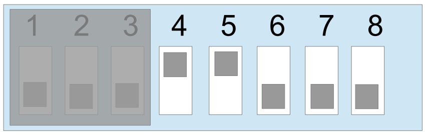
Breaker	1	2	3	4	5	6	7	8
Joining	2	1	4	3	No	No	No	No
Current	10A	10A	10A	10A	10A	10A	10A	10A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

Profile 3



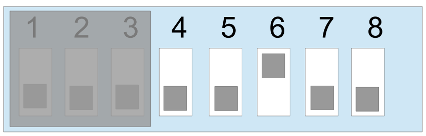
Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	10A	10A	10A	10A	5A	5A	5A	5A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

Profile 4



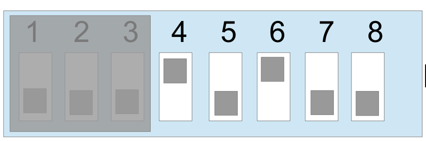
Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	10A	10A	10A	10A	5A	5A	2A	2A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

Profile 5



Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	10A	10A	5A	5A	5A	2A	2A	2A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

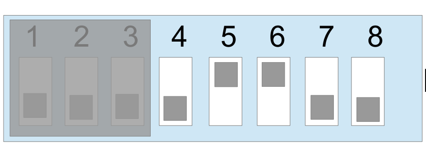
Profile 6



Breakers 1+2 joined = 20A

Breaker	1	2	3	4	5	6	7	8
Joining	2	1	No	No	No	No	No	No
Current	10A	10A	10A	10A	5A	5A	5A	5A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

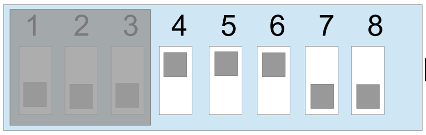
Profile 7



Breakers 1+2 joined = 20A

Breaker	1	2	3	4	5	6	7	8
Joining	2	1	No	No	No	No	No	No
Current	10A	10A	10A	10A	5A	5A	2A	2A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

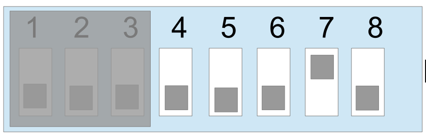
Profile 8



Breakers 1+2 and 3+4 joined = 20A * 2

Breaker	1	2	3	4	5	6	7	8
Joining	2	1	4	3	No	No	No	No
Current	10A	10A	10A	10A	10A	10A	5A	5A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

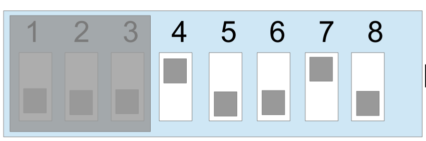
Profile 9



Breakers 1+2 and 3+4 joined = 20A * 2

Breaker	1	2	3	4	5	6	7	8
Joining	2	1	4	3	No	No	No	No
Current	10A	10A	10A	10A	10A	10A	5A	5A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

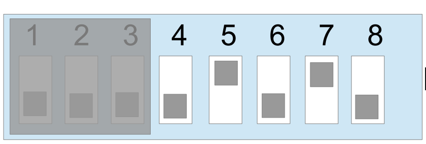
Profile 10



Breakers 1+2+3 joined = 30A

Breaker	1	2	3	4	5	6	7	8
Joining	2,3	1,3	1,2	No	No	No	No	No
Current	10A	10A	10A	10A	10A	10A	5A	5A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

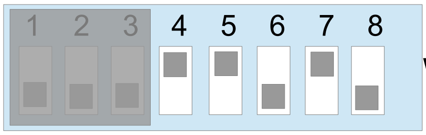
Profile 11



Breakers 1+2+3 joined = 30A

Breaker	1	2	3	4	5	6	7	8
Joining	2,3	1,3	1,2	No	No	No	No	No
Current	10A	10A	10A	10A	10A	5A	5A	2A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

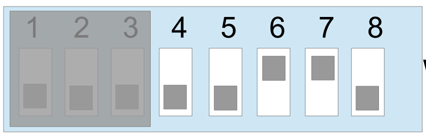
Profile 12



Wigwag on breakers 1 and 2

Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	10A	10A	10A	10A	5A	5A	2A	2A
Function	Wigwag1	Wigwag2	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

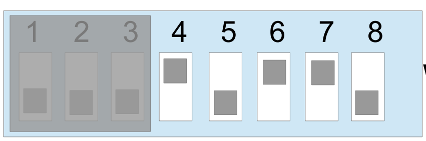
Profile 13



Wigwag on joined breakers = 20A per set 1+2 and 3+4

Breaker	1	2	3	4	5	6	7	8
Joining	2	1	4	3	No	No	No	No
Current	10A	10A	10A	10A	10A	10A	5A	2A
Function	Wigwag1	Wigwag1	Wigwag2	Wigwag2	Breaker	Breaker	Breaker	Breaker

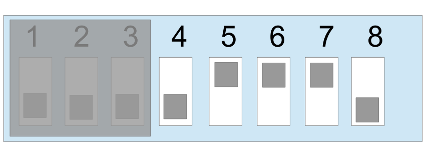
Profile 14



Wigwag on joined breakers = 20A per set 1+2 and 3+4

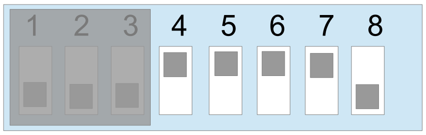
Breaker	1	2	3	4	5	6	7	8
Joining	2	1	4	3	No	No	No	No
Current	10A	10A	10A	10A	10A	10A	5A	5A
Function	Wigwag1	Wigwag1	Wigwag2	Wigwag2	Breaker	Breaker	Breaker	Breaker

Profile 15



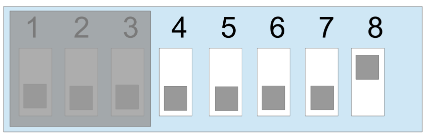
Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	5A	5A	5A	5A	5A	5A	5A	5A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

Profile 16



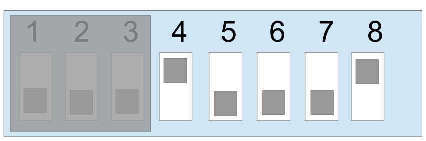
Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	5A	5A	5A	5A	2A	2A	2A	2A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

Profile 17



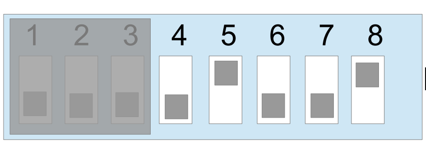
Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	10A	10A	5A	5A	5A	5A	2A	2A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

Profile 18



Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	10A	10A	5A	5A	2A	2A	1A	1A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

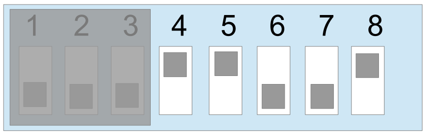
Profile 19



Breakers 1+2 joined = 20A

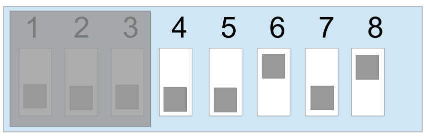
Breaker	1	2	3	4	5	6	7	8
Joining	2	1	No	No	No	No	No	No
Current	10A	10A	10A	5A	2A	2A	2A	1A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

Profile 20



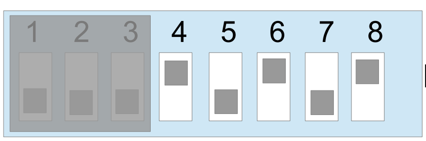
Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	2A	2A	2A	2A	2A	2A	2A	2A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

Profile 21



Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	1A	1A	1A	1A	1A	1A	1A	1A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

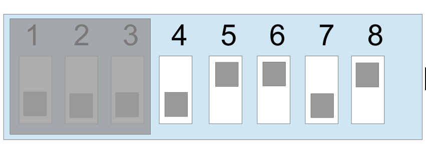
Profile 22



Breakers 1+2+3 joined = 30A, 5+6 joined = 20A

Breaker	1	2	3	4	5	6	7	8
Joining	2,3	1,3	1,2	No	6	5	No	No
Current	10A	10A	10A	10A	10A	10A	10A	10A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

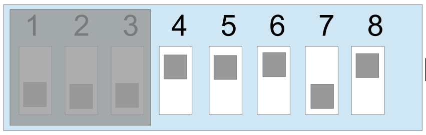
Profile 23



Breakers 1+2+3 joined = 30A, 5+6 joined = 20A

Breaker	1	2	3	4	5	6	7	8
Joining	2,3	1,3	1,2	No	6	5	No	No
Current	10A	10A	10A	10A	10A	10A	5A	2A
Function	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker	Breaker

Profile 24



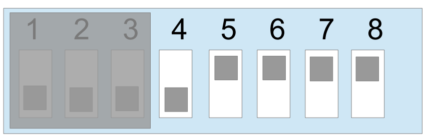
Flasher on breakers 5 and 6

Breaker	1	2	3	4	5	6	7	8
Joining	No	No	No	No	No	No	No	No
Current	10A	10A	10A	10A	10A	10A	5A	2A
Function	Breaker	Breaker	Breaker	Breaker	Flasher1	Flasher2	Breaker	Breaker

Profiles 24-30 are not used

If selected, the system will use profile 1

Profile 31

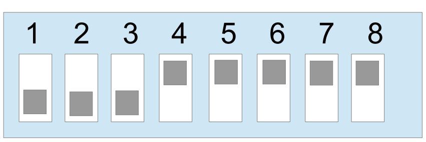


This profile is called the “programmable” profile. The individual breaker profiles are programmed using an external device.

The external device can select trip currents in steps of 0.1A and trip delay times in steps of 0.01 second. It also selects breaker doubling and tripling, WigWag and Burst Flash modes.

The external device can program the desired breaker settings regardless of profile selected. However they will only be used if profile 31 is selected.

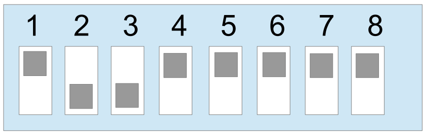
Profile 32 – Set Dual LED



This profile with switches 1,2,3 set in the above position selects dual LED operation (typically green switch status and red fault status LED, either as two LEDs or a single dual color LED).

Place dipswitches in above position and power up the ECB module. The ECB's green LED will flash rapidly to confirm programming completed. You can now remove power and select desired profile.

Profile 32 – Set Single LED



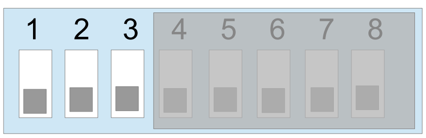
This profile with switches 1,2,3 set in the above position selects single LED operation (typically green or blue LED, off=breaker off, on=breaker on, flash=breaker faulted (tripped)).

Place dipswitches in above position and power up the ECB module. The ECB's green LED will flash rapidly to confirm programming completed. You can now remove power and select desired profile.

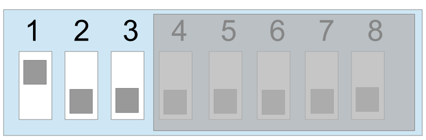
ECB node address

If the ECB module is used with an external device, it is required to set the node address of the module before connecting to the EFIS CAN bus (or RS232 port in case of third party applications).

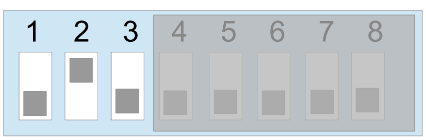
8 node addresses are available giving a total of 64 breakers in a system.



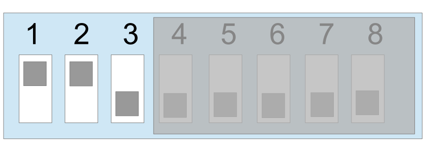
Node address 1, breakers 1-8



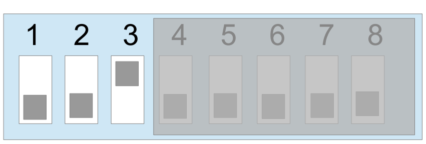
Node address 2, breakers 9-16



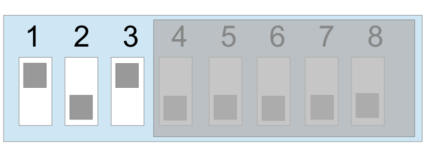
Node address 3, breakers 17-24



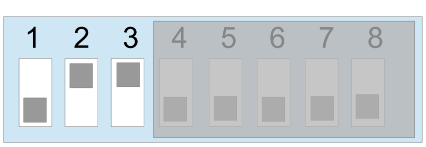
Node address 4, breakers 25-32



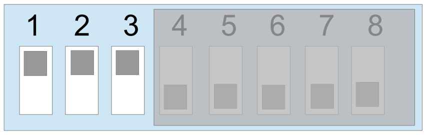
Node address 5, breakers 33-40



Node address 6, breakers 41-48



Node address 7, breakers 49-56



Node address 8, breakers 57-64

Wigwag function

The wigwag function is enabled either by profile selection or EFIS programming if the programmable profile (profile 31) is used.

You can choose either two single breakers (1 and 2) or you can use 2 sets of 2 breakers (breaker doubling 1+2 and 3+4) if higher currents are demanded.

Connect one set to the left wing landing lights and one set to the right wing landing lights. In case of all landing lights in a single wing, consider two sets of landing lights in a wing, each connected to a wigwag breaker set.

Wigwag may be operated by panel switch or via EFIS.

If operated via EFIS, you can consider bridging the wigwag breaker control inputs to ground (no panel switches or LEDs needed). Note that in case of EFIS failure you will not be able to switch landing lights on or off. In case of ECB failure, the landing lights will be on.

The recommended method of wiring Wigwag is to use a single panel switch connected to each wigwag breaker control input. This switch would then ground all wigwag breaker control inputs to switch the landing lights on. On each switch off-on iteration, the mode will change. If the switches are off, the landing lights are off. If on, depending on iteration, the landing lights will be solidly on or they will flash in “wigwag” fashion.

This can be used together with remote control from an EFIS if the panel switch is “on”.

Flasher function

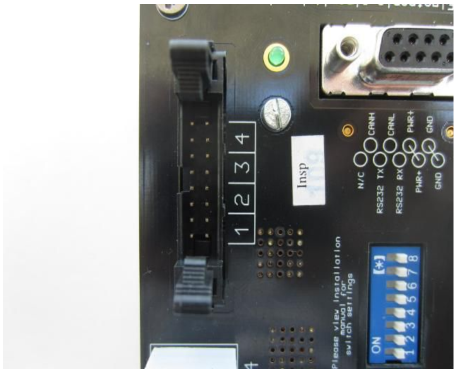
The flasher function uses breakers 5 and 6. Each is connected to a high brightness LED, typically a 12V LED or two 12V in series in case of a 24V system. Typical, easily obtainable LED lamps for this are 12V LED down lighters which come in wattage ratings up to 8W giving very bright light. Such a LED uses 1.5 A making it possible to drive as many as 6 of these on a single breaker (or 12 in case of a 24V system).

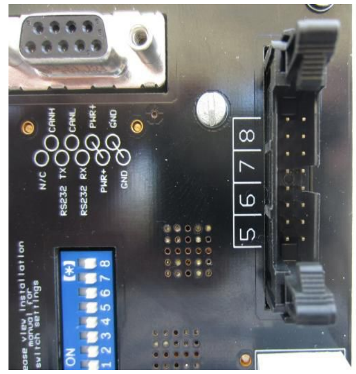
Each breaker flashes three times rapidly within a 1.2 second interval = 50 bursts per second (FAA FAR23 requirements 40-100 per second). The breakers are sequenced so no two breakers will be in the “on” state at the same time so peak current demand is that of a single breaker.

Flash “ON” time is 40mS, “OFF” time between flashes of a burst is 40mS.

The 16 pin connectors for LEDs and panel switches

The ECB module provides two IDC 16 way connectors with retaining clips.





Each connector serves 4 breakers using 4 conductors:

Ground – connects to the power supply negative of the ECB. Common to panel switch and both LEDs.

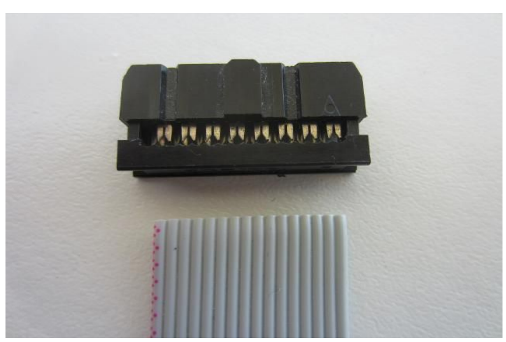
Panel switch – a latching N/O low current switch. Toggle switches or push button switches are common choices. Connects to ground.

Status LED. Normally a green LED or the green part of a two color LED. Connect to the anode of the LED, Cathode connects to ground. Note: In single LED operation this line is not used.

Fault LED. Normally a red LED or the red part of a two color LED. Connect to the anode of the LED. Cathode connects to ground. Note: In single LED operation this line connects to a green or blue LED.

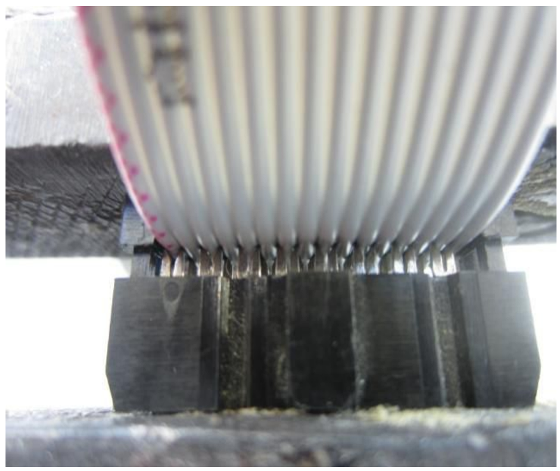
Preparing a IDC female connector

Joining the connector to a flat ribbon cable is done either using a dedicated tool or can easily be done using a common bench vice as shown here. Do not use pliers as it is difficult to use these to apply even force.



A small triangle on the connector denotes “pin 1”. It is not of importance in this application. You can insert the cable from either side of the connector as you wish.

Insert the cable so a few mm shows on the other side. Ensure cable is straight and the connector blades line up exactly with each cable core. Then simply use the vice to squeeze the two connector parts together until they latch.



Close-up of the connector before closing it using the vice. Note how each cable core lines up exactly with its corresponding connector blade.

When closed, each blade cuts into the insulation and forces itself around the metal conductor creating a high reliability, gas tight connection.

It is important that you ensure the cable is lined up correctly to ensure reliable connections.

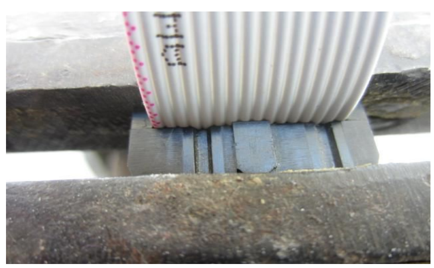


Image showing the connector closed. Only a small force is needed when using a bench vice.

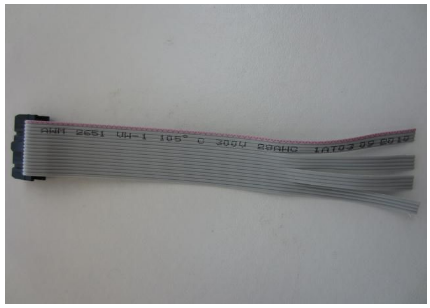
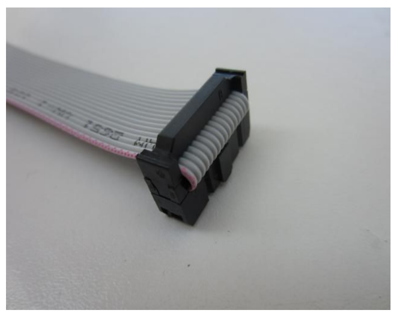


Image of a short cable connection ready for use. Split off 4 groups of 4 wires as shown in the image. There is no practical restriction to the length of the cable, you can make it any length you need. The ECB kit contains about 10 feet of 16 way ribbon cable. Contact your supplier if you need longer cable.

Image showing the cable strain relief clip.



Fold the cable over the top of the connector and insert the train relief clip until it latches on both sides.

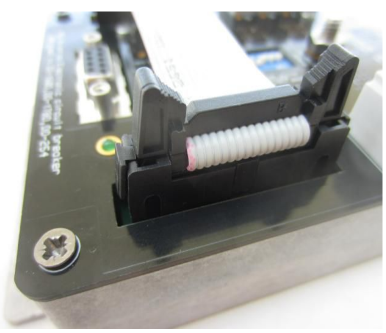
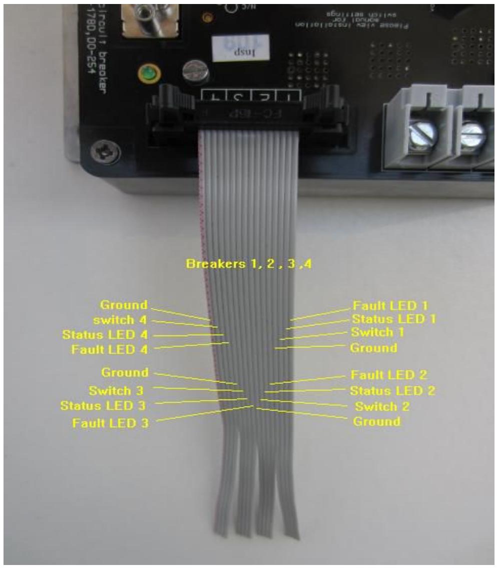
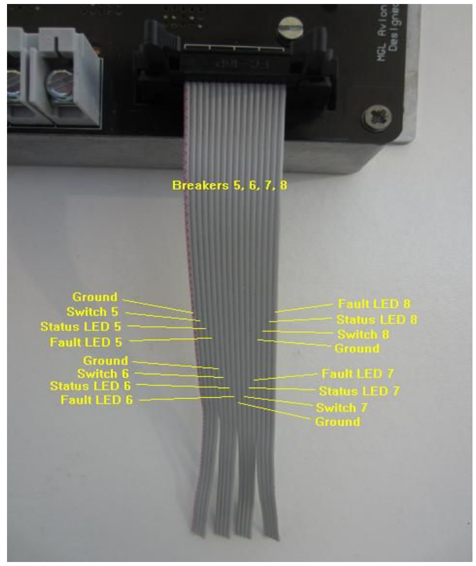


Image showing connector with strain relief clip inserted in one of the ECB connectors. The two restraining clips clip over the strain relief and hold the connector securely in place. To remove the connector, simply force the two clips apart - this levers the connector out.

Note that you can insert the cable into the connector from any direction so you can choose the cable exit path as your needs dictate.

Identifying connections





Interface to an external device

The ECB provides two types of interface:

RS232

The RS232 port contains a RX (receive) and a TX (transmit) line. In case more than one ECB is used in a system, the ECB modules are daisy chained. This means the TX line of one module goes to the RX line of the next module. Each module must have a unique address set with dipswitches 1,2 and 3. The modules may be wired in any order. The RX of the first module and TX of the last module in the chain is then wired to the external device.

Note: The RS232 interface is **NOT** used with MGL EFIS systems and can be left unconnected.

CAN bus

Note: In MGL EFIS systems the CAN bus is used to connect to the ECB. Up to 8 ECB modules giving a total of 64 breakers may be connected. You must set each module to a unique address using dipswitches 1,2 and 3.

The CAN bus consists of two conductors that should form a “twisted pair”. One conductor is called “CAN-High”, the other “CAN-Low”. The CAN bus is wired to all devices taking care that all device CAN-High connections are wired to the bus line “CAN-High” and device CAN-Low are wired to the bus line “CAN-Low”.

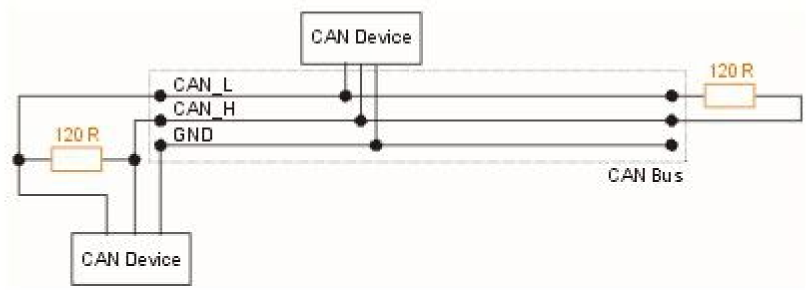
The CAN bus forms a single twisted pair cable going from device to device with only short stubs (1 ft, 30cm or less) permitted for each device connection.

In order to operate the CAN bus must be terminated with two resistors. Each end of the CAN bus must have a 120 ohm resistor wired from CAN-High to CAN-Low. For short runs typical in a small aircraft it is permissible to use just a single resistor of 60-100 ohm value anywhere on the bus between CAN-High and CAN-Low.

It is permissible to use shielded cable containing the two CAN bus wires. In this case it is recommended that the shield be connected to ground at a single location only (so no currents can flow through the shield).

CAN bus primer

The CAN bus (Controller Area Networking) was defined in the late 1980 by Bosch, initially for use in automotive applications.
It has been found to be very useful in a wide variety distributed industrial systems and is becoming popular in avionics applications due its robustness and ease of use.



The connection uses two wires which are twisted around each other. This forms a “balanced transmission line”. It helps to reduce emissions and also makes the link more robust against external interferences.

The CAN bus is always implemented as a single cable allowing only short stubs to connect to equipment along the route. Never implement a CAN bus as a “star” or other wiring topology.

The CAN bus requires termination resistors at each end of the bus. These are to be 120 ohm resistors. 1/4W or 1/8W resistors are usually used here. The resistors must be installed at each end of the bus, not in the center or anywhere else.

For short CAN runs (less than three meters) it is possible to install a single resistor of lesser value (not less than 60 ohms) at any location in the cable run.

The two wires are referred to “CAN High” and “CAN Low”. These must connect to the corresponding lines at the devices. Never swap these connections (I.e. Never connect CAN H to CAN L at any device) as the CAN bus will not be able to function.

Never run the CAN bus connection inside a wire harness next to sensitive connection such as audio or signal wires. Never run the CAN bus next to RF cables.

Making twisted wire

It is very easy to make your own twisted wire. Simply take two equally long wires (for example 5 meters) in parallel and tie one end (both wires) to a fixture (a door handle works well). Insert the other end (both wires) into a drill. Stretch the wires so they are straight. Run the drill for a few short bursts at slow speed and you have a created a perfect twisted pair !

Shielded, twisted wires

It is possible to purchase shielded, twisted wire. This can be used in applications where there may be electrical noise issues. In this case we advise to connect the shield to ground AT A SINGLE LOCATION ONLY. This prevents creating a “ground loop” which can cause EMI issues.

Basic wiring checks

You can use a volt meter to perform basic checks on a CAN connection.

With at least one device connected and powered you should be able to measure voltages of around 1.0 – 3.0 volts on each cable with respect to ground. The voltage should appear very similar on each connection.

Technical data

Breaker

Maximum continues DC current through each breaker: 10A

Maximum current through each breaker: 45A (ultimate trip current)

Maximum die temperature of each breaker: 165 degrees Celsius. Breaker will switch off when reaching this temperature.

Breaker clamp voltage:
65V (if input voltage rises above output voltage by 65V the breaker will start conducting and attempt to clamp the voltage at 65V in order to protect itself.

Trip currents depend on selected profile.

Trip times for profiles other than profile 31 (programmable profile) are fixed to 0.5 seconds multiplied by the inverse of the over current ratio. For profile 31 trip times are programmable from 0 seconds in steps of 0.01 second.

Example: Breaker trip current = 5A, trip time 0.5 seconds, breaker current = 5A.

Trip time = 5/5*0.5 = 0.5 seconds

Example: Breaker trip current = 5A, trip time 0.5 seconds, breaker current = 10A.

Trip time = 5/10*0.5 = 0.25 seconds

Example: Breaker trip current = 5A, trip time 0.5 seconds, breaker current = 20A.

Trip time = 5/20*0.5 = 0.125 seconds

Currents during the over-current time period are integrated accordingly.

Breaker features “soft start” to protect equipment from sudden rise of voltage.

Soft start characteristics:

Turn on time to 20% of Voltage: 35uS typical.
Rise time from 20% to 80% of Voltage: 17uS typical.

Replacement semiconductor switch element: AUIPS7111S, International Rectifier. Note: Please use Automotive qualified parts only.

ECB module general

Maximum total continues input current through input terminal: 60A

Maximum total instantaneous current through input terminal (1 second): 150A

Maximum voltage with respect to ground on breaker input and output: 35V DC

Supply voltage for ECB (on D9 connector): Maximum 35VDC.
Supply current @13.8VDC is under 50mA.

Note: Supply current for ECB will be taken either from the breaker input terminal or the supply pin 4 on the D9 connector depending on which voltage is the higher.

Control interface

Switch current (switch closed): 3mA

Switch voltage (switch open): 2.6V (up to 3.3V if zero load).

LED outputs

3.3V via 68 ohm resistor into anode of LED, cathode at 0V.
Typical currents depend on LED threshold voltage and are in the order of 20mA.

RS232 port

Baudrate 38400, 8 data bits, 1 stop bit. Daisy chain topology if more than one breaker used in system. Up to 8 ECB modules in a daisy chain.
Please contact MGL Avionics if protocol information is required.

CAN port

Implements CAN 2.0 with 11 bit identifiers at 250KBaud. Up to 8 ECB modules may be connected to one CAN bus. For protocol information please view MGL CAN bus protocol document available for download on MGL Website: www.MGLAvionics.co.za

Installation guidelines

The ECB module must be installed in a well ventilated area. Avoid confined spaces with no airflow that may give rise to excessive temperatures.
Install a fan to promote airflow if no other solution is possible.

Avoid locations where high ambient temperatures may be encountered.

Excessive temperatures may reduce the maximum current capability of the ECB.

Avoid locations where excessive vibration may be coupled onto the ECB module or any attached wiring.

Only use conductors that are able to handle the expected currents without excessive self heating.

Ensure cable insulation retains required properties over time and temperature.

Ensure that all terminals are secure and are protected against vibration in an adequate manner.

Ensure no cables will chafe against airframe parts so cable insulation may be damaged.

Ensure all cables and connections are adequately insulated and protected against corrosion as needed.

CURRENT CARRYING CAPACITY					
AWG Size	Amperes per Conductor Copper Temperature				
	80°C	90°C	105°C	125°C	200°C
30	2	3	3	3	4
28	3	4	4	5	6
26	4	5	5	6	7
24	6	7	7	8	10
22	8	9	10	11	13
20	10	12	13	14	17
18	15	17	18	20	24
16	19	22	24	26	32
14	27	30	33	40	45
12	36	40	45	50	55
10	47	55	58	70	75
8	65	70	75	90	100
6	95	100	105	125	135
4	125	135	145	170	180
2	170	180	200	225	240

Comparison between mechanical and electronic circuit breakers

The ECB (Electronic Circuit Breaker) is a replacement for the traditional mechanical circuit breaker.

Mechanical breakers use heat created by the current through a resistive wire to bend a bi-metal part that unlatches a switch if a certain temperature is reached.
The time it takes for the breaker to “trip” depends highly on ambient temperature, the amount of current through the breaker as well as mechanical tolerances which can be great.
Long term effects on materials and wear also have a large influence.

Time/Current/temperature curves are usually published by manufacturers of these breakers.

Electronic breakers do not have any of these issues. As no power needs to be drawn from the current source to heat a wire the electronic breakers tend to have a very low “on” resistance (in case of this product at little as 0.003 ohms). This means less heat and near zero power loss over the breaker. Breaker trip points are now controlled by a microprocessor as well as an ultimate trip point in case of microprocessor failure. Due to this trip points are tightly defined and trip behavior and times are well defined. Unlike mechanical breakers, trip times can now be made much shorter offering better circuit protection and enhanced safety.

The ECB has a default trip time of 0.5 seconds which is shortened as current increases. This allows the ECB to absorb typical inrush currents when equipment is switched on which may exceed normal operating currents while still offering much superior protection. Using the EFIS programmable profile longer or shorter trip times may also be set depending on needs.

Comparison of mechanical to electronic breaker (from manufacturer data of a FAA certified mechanical breaker – times stated here do not take into account tolerances which are large)

Of rated current	Mechanical breaker	Electronic breaker (default)
100.00%	>100 seconds	0.5 seconds
200.00%	~ 10 seconds	0.25 seconds
400.00%	~ 2 seconds	0.125 seconds
1000.00%	~ 0.3 seconds	0.05 seconds

Mechanical breakers have a lifetime restriction of 5000 actions on a typical load, electronic breakers are not limited in the number of actions.

ECB modules allow decentralization of power switching and overcurrent protection. It is not required any longer to wire high current conductors behind the panel, instead low current, reliable latching switches, LED indication which is visible in darkness and small diameter, low current wiring is used.

ECB systems, when connected to an EFIS system allow display of individual breaker states (on, off, faulted) and currents measured through each breaker. Depending on configuration the EFIS may also be used to switch breakers and reset fault states.

Having the ability to show currents through each breaker at any time is an invaluable diagnostics tool for any aircraft's electrical system.

Environmental compliance of the ECB module

DO-160 compliance statement based on Do-160D

Temperature and Altitude	4.0	Equipment intended for use with categories A4, C4
Low temperature ground survival (declared)	4.5.1	-55°C
Low temperature operating (declared)	4.5.1	-20°C
High temperature operating (declared)	4.5.3	+55°C
High temperature short-time operating (declared)	4.5.2	+70°C
High temperature ground survival (declared)	4.5.2	+85°C
Loss of Cooling	4.5.4	No cooling required
Altitude	4.6.1	No restriction
Decompression	4.6.2	No restriction
Overpressure	4.6.3	No restriction
Temperature Variation	5.0	Equipment complies with Category C
Humidity	6.0	Equipment complies with Category A
Operational Shocks	7.2	Equipment complies with Category B
Crash Safety	7.3	Equipment complies with Category A
Vibration	8.0	Compiles with Categories S, R
Explosion	9.0	Not applicable
Waterproofing	10.0	Not applicable
Fluids Susceptibility	11.0	Not applicable
Sand and Dust	12.0	Not applicable
Fungus	13.0	Not applicable
Salt Spray	14.0	Not applicable
Magnetic Effect	15.0	Not applicable
Power Input	16.0	Equipment complies with Category B
Voltage Spike	17.0	Equipment complies with Category B
Audio frequency conducted susceptibility	18.0	Equipment complies with Category B
Induced signal susceptibility	19.0	Equipment complies with Category AC
Radio frequency susceptibility	20.0	Equipment complies with Category T
Radio frequency emission	21.0	Equipment complies with Category B
Lightning induced transient susceptibility	22.0	Not applicable
Lightning direct effects	23.0	Not applicable
Icing	24.0	Not applicable

Electrostatic Discharge	25.0	Category A on breaker inputs and outputs

DO178D software assurance statement for ECB module

The firmware in the ECB is designed according to DO178 level D guidelines related to:

Software life cycle

- Firmware update distribution
- Firmware update procedures

Software functional testing and validation

- ECB breaker control
- ECB breaker current monitor
- ECB breaker fault detection and control
- ECB breaker special functions
- CAN and RS232 protocol tests and validation
- Storage and retrieval of setups
- Software recovery in case of external or internal induced malfunction
- Firmware update process and correctness of code checks

Software documentation

- Procedures
- Program flow
- Parameters and returns
- Data structures
- Protocols

DO254 electronic hardware assurance statement for ECB module

The ECB hardware is designed based on DO-254 guidelines:

Hardware design life cycle

- Design iterations – Flow

Hardware design process

- Steps from concept to prototype for each iteration

Validation and verification process

- Testing and verification of actual functionality and electrical performance against design goals

Transfer to production process

Notes on DO-160, DO-178, DO-254 statements in this document

The ECB module is intended for use in non-type certified aircraft or any aircraft where fitting of non-approved equipment is permitted or requires additional approvals (modification approval or STC).

Documents DO-178 and DO-254 referred to here provide guidelines on the process of certification which would involve at an early stage the certification authority. This has not been adhered to as there is no intention of certifying this equipment. However, the documents retain their validity and have nevertheless been used as foundation to the design of this equipment.

Document DO-160 however is different in that it specifies and details the process of numerous tests to be performed on the equipment. These tests have been carried out under self-certification rules as part of the design verification and the results published in this document.