

MIAC-01

Now you are in control

Operation and Programming guide

MI3278



MATRIX

Maximum ratings

Power supply (V+)	16VDC, 2A
Transistor output supply (M)	28VDC, 4A
Inputs (I1 - I8)	-30V to +45V
Transistor outputs (A,B,C,D)	±1.75A, 0 to 28VDC
Relay outputs (Q1 - Q4)	8A @ 240VDC (Resistive) 8A @ 30VDC (Resistive)
Storage temperature	-40°C to +70°C
Operating temperature	-5°C to +50°C
IP rating	20

Warnings

The MIAC unit can operate with hazardous voltages which can result in electric shock or other potentially fatal injuries.

- Disconnect all power sources before working on this equipment.
- Do not operate the equipment with case open.
- Avoid all contact with the connector terminals when any power sources are connected.
- Ensure all wiring is in good condition and correctly terminated.

Certification

CE certification:

EN 60950-1: 2001+A11:2004

EN 55022: 2006 Class B

EN 55024: 1998+A1: 2001+A2: 2003

FCC certification:

ANSI C63.4 (2003)

CISPR 22: 1997+A1: 2000

ICES-003: 2004

Introduction



What does it do?

MIAC (Matrix Industrial Automotive Controller) is an industrial grade control unit which can be used to control a wide range of different electronic systems. It has a number of applications in industry and learning.

Benefits

- Flexible and expandable
- Easy to program with flowcharts, C or Assembly code
- Physically and electrically rugged

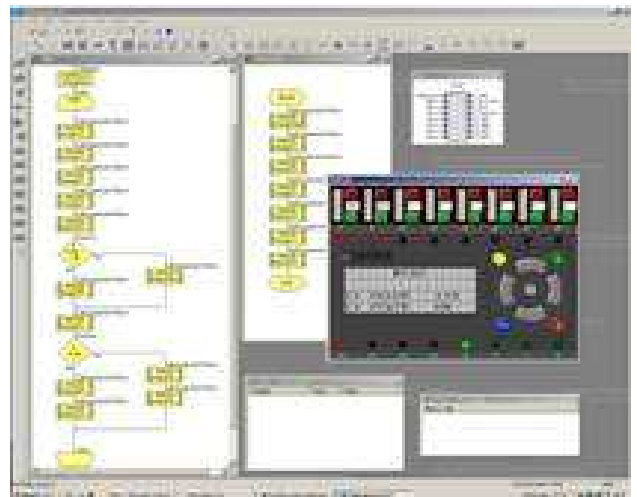
Features

- Programmable from USB
- Compatible with Flowcode and C
- 8 digital or analogue inputs
- 4 relay outputs, 4 motor outputs with speed control
- 4 line LCD display and control keys
- Lab View and Visual Basic compatible

Description

The MIAC is a fully specified industrial electronic controller designed to operate off 12 to 16V DC. It has 8 analogue or digital inputs, 4 high current relay outputs and 4 motor outputs. The MIAC is housed in an attractive, rugged, anthracite grey plastic moulding. It has two physical mounting options: it can be mounted onto a 35mm 'top hat' DIN rail, or it can be mounted directly onto any surface using the 4 screw holes provided.

The MIAC unit has screw terminal connector inputs across the top and bottom of the unit, has several input buttons for user control, and also has a 4 line 16 character alphanumeric display on the top of the unit to display system status and assist users.



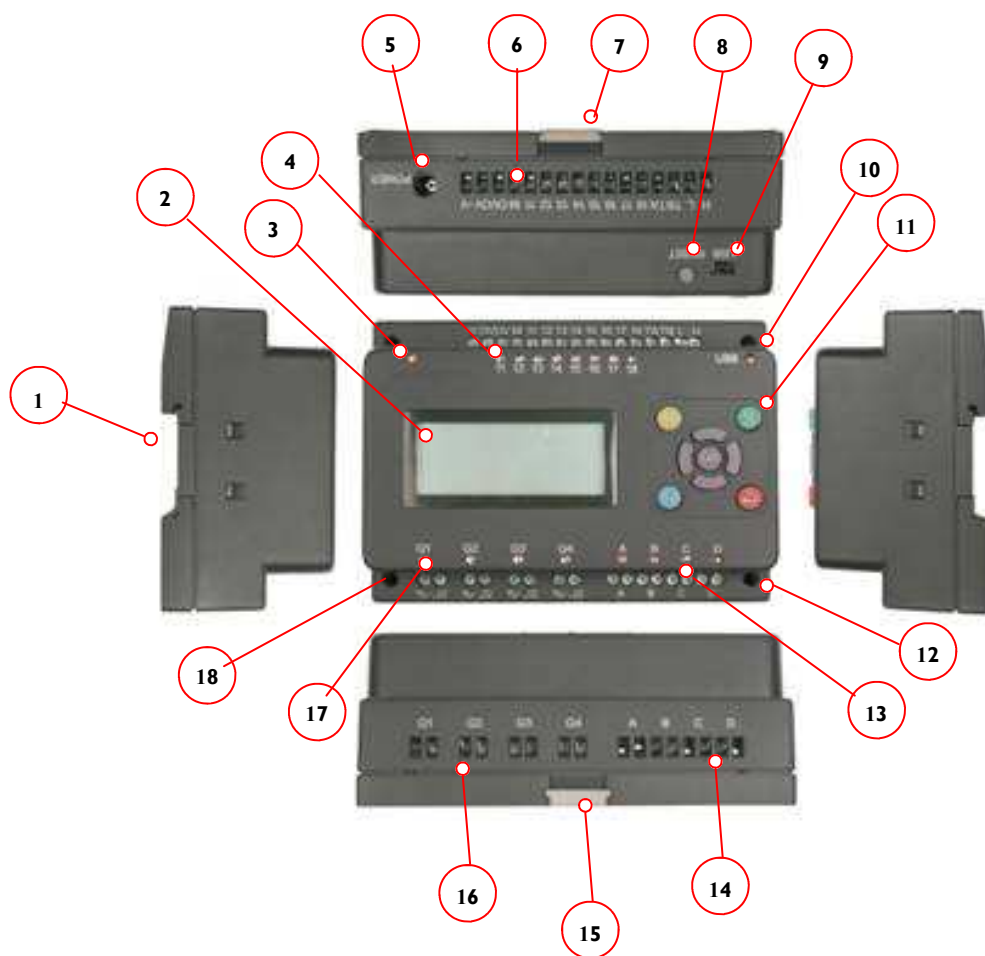
Flowcode- the graphical programming language supplied with MIAC

The unit is programmed directly from a PC's USB port and is compatible with the Flowcode graphical programming language. Users can develop a program using Flowcode, press the Reset button on the back of the unit, and the program will automatically download and start. The MIAC can also be programmed in C and assembly code, or any program that produces a HEX file for the PIC18F4455 microcontroller.

MIAC is equipped with a fully operational CAN bus interface so that many MIACs can be networked together to form wide area electronic systems.

A DLL and sample programs are provided to enable MIAC to be used with PC based control programs like LabView, Visual Basic, C++ etc.

MIAC hardware



Key

1. Top hat rail mounting recess
2. 16 character x 4 line LCD display
3. Power LED
4. Input status LEDs
5. 2.1mm power jack
6. Screw terminal inputs
7. Top hat rail retainer clip - upper
8. Reset / run switch
9. USB socket
10. USB transfer LED
11. Control keys
12. M3 mounting holes
13. Motor status LEDs
14. Motor output screw terminals
15. Top hat rail retainer clip - lower
16. Relay output screw terminals
17. Relay output status LEDs
18. M2 mounting holes

MIAC is housed in a custom-made plastic moulded housing which can be mounted using standard M2.5 bolts, or can be mounted on a 'top hat' DIN rail. If using a DIN rail two retainer clips are used to lock the unit in place on the rail.

The unit has 8 analogue or digital inputs, 4 relay outputs, 4 transistor outputs, and a CAN bus interface. The unit is powered by an 18F4455 18 series PICmicro microcontroller from Arizona Microchip.

Inputs are fed into a signal conditioning circuit which allows them to be used as both analogue and digital inputs. Software dictates their operation as an analogue input or as a digital input. Inputs are not optically isolated. Signal conditioning powers the topside LEDs which show analogue inputs at the appropriate brightness relative to the voltage input. The input range is 0 to 12V DC which makes the MIAC compatible with industry standard sensors.

4 outputs from the PIC processor are fed into a power stage which provides current amplification before feeding them to 4 separate relays. Fusing for relay circuits should be provided externally.

4 additional outputs are fed into a motor driver stage, including current monitor with shutdown circuitry which limits the output current and protects the motor

driver chip in case of short circuits. Output status is reflected by topside LEDs - where Pulse Width Modulation is used (only available on two of the 4 outputs) LED brightness reflects duty cycle.

The internal processor also connects to a CAN bus driver circuit which allows many MIACs to be connected together to form an industrial control network.

Great care has been taken to ensure that the MIAC is electrically rugged - it is possible to short out any input to any output or any one output to any other without the unit failing. Relay contacts are not current limited and external fuses should be used to limit relay current to 8A AC or DC.

Control and monitoring of processes is facilitated by a 4 line LCD display and a customisable keypad.

The MIAC is supplied with a version of Flowcode 3 professional (limited chip set) which allows users to program the device using flow charts.

Bootloader firmware within the MIAC allows PIC18F4455 HEX files from any source (C, assembler etc.) to be downloaded via the USB interface. Programs must be relocated in program memory to start at address 0x0800 to avoid overwriting the bootloader.

Using MIAC with Flowcode

MIAC has been developed in conjunction with Flowcode to provide an integrated development environment.

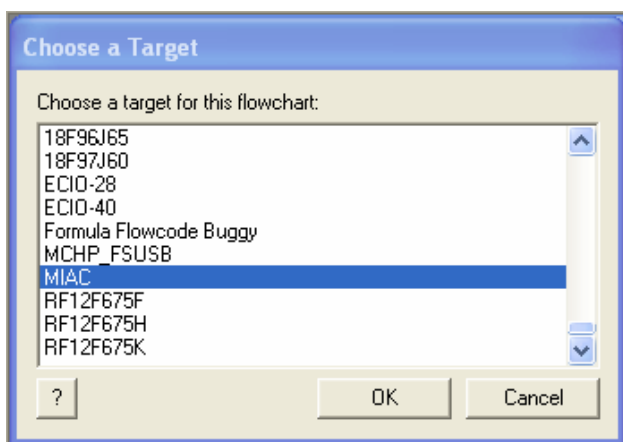
Flowcode provides:

- Macros to allow easy access to all the MIAC features.
- Simulation functions for most programs
- Optimised program compilation
- Single button programming of the MIAC
- In Circuit Debugging (V4 only)

MIAC can also be programmed with code from alternative sources. See 'Using MIAC with other development tools'

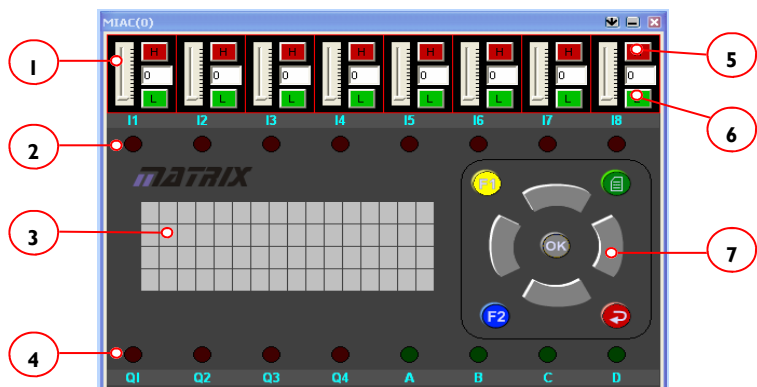
Getting started using Flowcode

Open a new flowchart in Flowcode. Select MIAC as the target device:



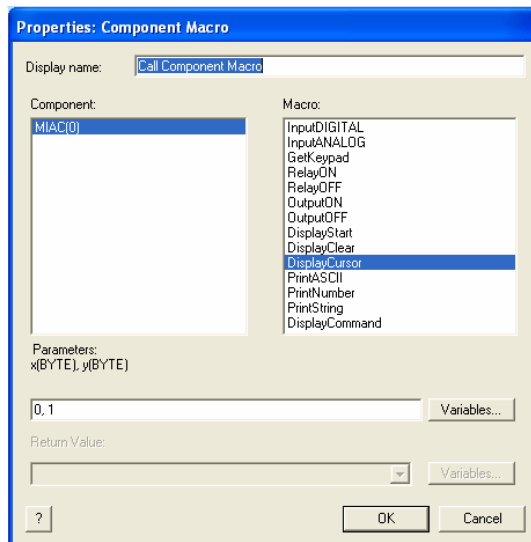
Selecting the MIAC as a target in Flowcode

Click on the MIAC icon on the tool bar to load the MIAC component onto the flowchart which will reveal the MIAC component shown below. Within Flowcode it is possible to call macros for all the basic input and output functions, to read the keypad, and to control the LCD display and to see the results on the simulation component.



The MIAC simulation component within Flowcode

1. Analog slider controls and conversion value displays
2. Input status indicators
3. 16 x 4 character LCD
4. Output status indicators
5. Digital high buttons
6. Digital low buttons
7. Keypad



Calling MIAC functions with Flowcode

Flowcode MIAC macros

InputDIGITAL

Return the logic level of the specified input.

InputANALOG

Return the analog voltage value from the specified input (20 x voltage)

GetKeypad

Scan the keypad and return the value of any key being pressed. Return 255 if no key is being pressed.

DisplayStart

Initialise the LCD (must be run before any other display command is used)

DisplayClear

Clear the LCD and return the cursor to the home position

DisplayCursor

Move the invisible LCD display cursor to the specified location

PrintASCII

Print the specified ASCII characters to the LCD, starting at the current cursor location

PrintNumber

Print a left-justified byte or integer value to the LCD, starting at the current cursor location

PrintString

Print a string to the LCD, starting at the current cursor location

DisplayCommand

Send a command/control character directly to the LCD

RelayON

Turn the specified relay on

RelayOFF

Turn the specified relay off

OutputON

Turn the specified transistor output on

OutputOFF

Turn the specified transistor output off

Installing drivers and software

Drivers

Before using the MIAC, driver software must be installed. To do this:

1. Power the MIAC using a suitable power source (see specifications). Note: The MIAC can not be powered via the USB connector
2. Connect a MIAC to the PC using a USB cable.
3. Press the RESET button on the MIAC to start the bootloader software and establish USB communications. If the MIAC driver is not installed, Windows will detect the MIAC as new hardware and begin the driver installation process.
4. Make sure the installation CD is in the drive. When the 'found new hardware' dialogue window appears select the options to disable internet searching and enable automatic installation of the software. If a compatibility warning appears, select the 'Continue Anyway' option. The driver is now installed.

Programming MIAC

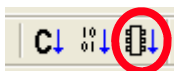
Each MIAC is shipped containing a small bootloader program that manages the transfer of programs into the internal flash memory via the USB port. The MIAC enters programming mode when a USB connection is detected during recovery from a RESET condition.

The two main causes of a RESET condition are connecting the power supply, and pressing the RESET button. If no USB connection is detected, MIAC will immediately run the program stored in its memory.

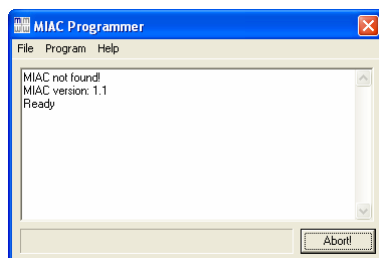
When in programming mode MIAC will wait for several seconds, with the USB LED flashing, trying to establish communications with a programming utility running on the host PC. If communications are not established, MIAC will run the program stored in its memory.

Programming from Flowcode

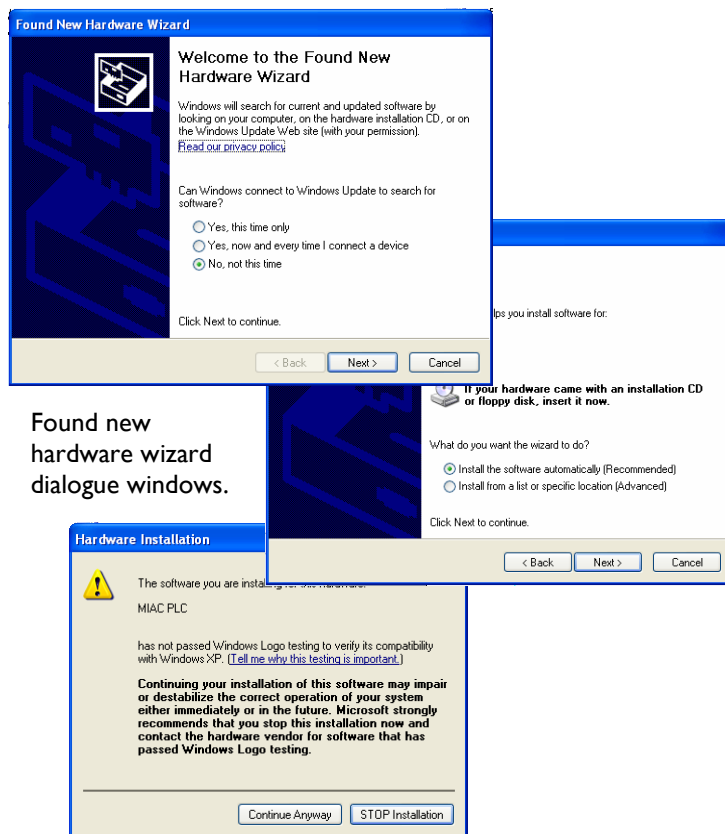
The MIAC programming utility (MIACprog.exe) is installed as part of Flowcode and will be automatically launched by Flowcode during the 'Compile to chip' operation.



If the MIAC is not in programming mode, a message will be displayed with the necessary instructions.



MIACprog



Using MIAC with other development tools

The MIAC bootloader and MIACprog programming utility are compatible with PIC18F4455 HEX files generated by most development tools. The only requirement is that it must be possible to relocate the code in program memory to start at the address 0x0800.

MIAC configuration fuse settings:

```
CONFIG1L=0x20
CONFIG1H=0x0E
CONFIG2L=0x3E
CONFIG2H=0x1E
CONFIG3H=0x00
CONFIG4L=0x81
CONFIG5L=0x81
CONFIG5H=0x00
CONFIG6L=0x0F
CONFIG6H=0x80
CONFIG7L=0x0F
CONFIG7H=0xA0
DEVID1=0x0F
DEVID2=0x00
```

Using MIACprog directly

When not using Flowcode to download programs to MIAC, MIACprog can be launched manually. If not installed as part of Flowcode, the MIACprog files can be found on the installation CD at:
<CD drive>:\etc\software\MIAC

See the MIAC.chm help file for more details on the use of this utility.

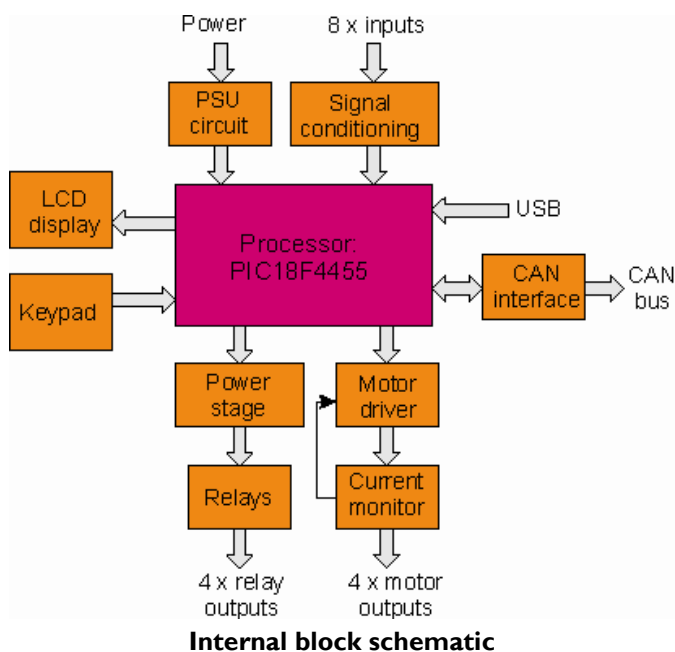
Internal block schematic

Internally the MIAC is powered by a powerful 18 series PICmicro device which connects directly to the USB port for fast programming. The PIC device is pre-programmed with a bootloader and a Windows utility is provided which allows programmers to download PIC compatible hex code into the device.

Inputs are fed into a signal conditioning circuit which allows them to be used as both analogue and digital inputs. (Not optically isolated.) Signal conditioning powers the topside LEDs which show analogue inputs at the appropriate brightness.

The outputs from the PIC processor are fed into a power stage which provides current amplification before feeding them to 4 separate relays. Fusing for relay circuits should be provided externally. Additional outputs are fed into a motor driver stage and current monitor with shutdown circuitry which limits the output current and protects the motor driver chip in case of short circuits. Output status is reflected by topside LEDs - for motor outputs LED brightness reflects motor speed / PWM ratio.

The PIC processor also connects to a two wire CAN bus driver circuit which allows several MIACs to be connected together to form an industrial control network. Control and monitoring of processes is facilitated by a 4 line LCD display and a customisable keypad.



Power supply circuit

Please refer to the schematic below.

MIAC can be powered with a DC supply voltage in the range 12V to 16V DC. The power can be supplied via the 2.1mm power jack (POWER), or the power supply terminals (V+, 0V). The power jack is fed into a bridge circuit and can therefore accept plugs wired with either connection polarity.

To prevent interference from high current switching spikes

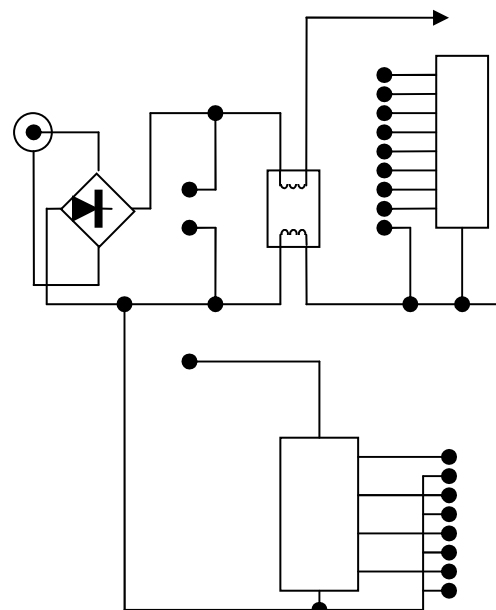
on the voltage rails the supply voltage is filtered inside the MIAC.

The 0R terminal is the common voltage for the internal logic circuits and is connected to the 0V terminals via the filter. This reduces the effects of the high current circuits on the control system, and provides an accurate reference voltage for input circuits, especially when being used as analogue inputs.

The transistor outputs are not powered internally. The M terminal is used to apply power to the transistors which allows a voltage other than the supply voltage to be used on the transistor outputs. If you wish to power the transistors from the same supply as the supply voltage then simply use a shorting link between the V+ and the M terminals.

The maximum value of M is nominally 12V DC but up to 28V DC can be used depending on the ambient temperature.

The transistor outputs are supplied by a single L298 device and can supply up to 1.75A each at 24V. Transistor outputs can be connected in parallel if more power is needed from an output.



Power supply schematic

Input circuits

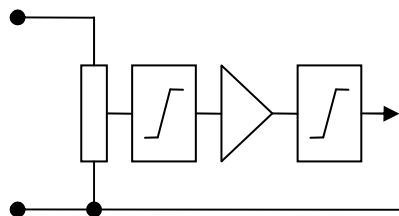
MIAC has eight identical inputs (I1 to I8) with an input voltage range of 0V to 24V, and an input resistance of 10K Ohms to 0R. Each one can be read as an analogue or digital value. Analogue conversion accuracy is maintained between 0V and 12V

Digital readings

Logic level switching occurs at input voltages between 3 and 8V DC. The logic levels are undefined for input voltages between these levels.

Digital inputs rely on the signal source switching cleanly between the two logic levels:

Logic 0: < 3V DC
Logic 1: > 8V DC

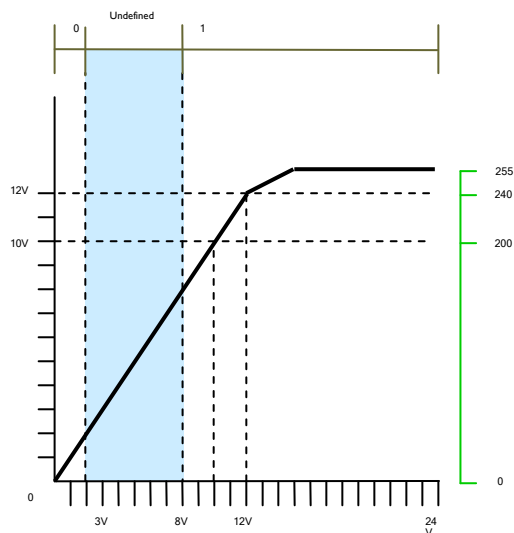


Schematic of each input

Analogue conversions

Analogue conversions have a resolution of 50mV (20 counts per Volt). This allows simple calculations to be used to convert the results of an analogue sample into a direct voltage representation - simply divide the input by 20.

Analogue conversion of input voltages above 12V will return the value of the clamping voltage (between 241 and 255)



Analogue input conversion

Reading a digital input with Flowcode

In addition to the input/output macros supplied by the MIAC component, it is also possible to read digital inputs using the Flowcode Input blocks. See the table below

Reading an input using other programming languages

Due to the internal allocation of microcontroller I/O for specific system functions, the external I/O is made up of individual pins from several ports:

INPUTS	
MIAC INPUT	MICROCONTROLLER PIN
I1	RA0
I2	RA1
I3	RA2
I4	RA4
I5	RE0
I6	RE1
I7	RE2
I8	RB2

Input resistance

Each MIAC input (I1—I8) represents a resistive load of 10K Ohm, $\pm 1\%$, to 0R when the input voltage is between 0V and 24V.

This resistance allows most industrial PNP output sensors to be used without additional load resistors. It can also be used as part of a potential divider in conjunction with other sensing devices (Thermistors, Light Dependent Resistors (LDRs), etc.).

The input resistance will affect voltages measured from signals with a high output impedance or a low current capacity.

- Signal sources must be capable of supplying 0.1mA per Volt of signal.
- Analogue voltage measurements from a source with an output resistance, R_s , will be reduced by a factor of $10K/(10K + R_s)$.

To achieve accurate analogue measurements, signals sources should be obtained from low resistance or buffered sources.

Output circuits

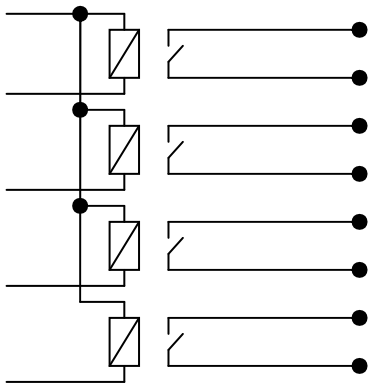
Relay outputs

MIAC contains four, single-pole, normally open relays. Q1 to Q4. Pairs of terminals provide access to the switch contacts of each relay.

The four pairs of relay contacts are isolated from each other, and from the MIAC control circuitry.

The relays are independently controlled by the MIAC. Each can switch up to 8A at 250VAC or 30VDC.

In order to retain the high isolation and low resistance switching properties of the relays, no protection devices have been added to the contact circuits. Care should be taken when switching loads that could exceed the voltage or current ratings of the contacts.



Relay outputs

Transistor outputs

MIAC provides four transistor controlled outputs. The four outputs have a common positive supply voltage (derived from the M terminal, 6 to 28V DC) and local 0V terminals.

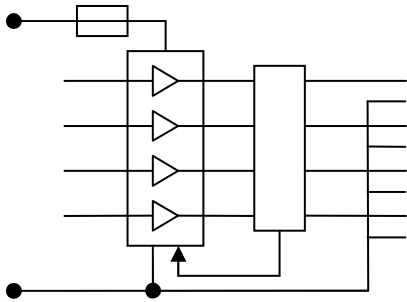
The transistor outputs include several protection devices to prevent accidental damage.

- Each output is current limited to approximately 1.75A sourcing or sinking.
- The supply from the M terminal is protected by a 4A resettable fuse.

The device driving the outputs contains a thermal protection circuit. Activation of any of the protection devices may cause all four transistor outputs to shut down for a short time period - depending on the nature of the fault

The transistor outputs are able to switch much faster than the relay output, allowing high frequency control signals to be generated. Two of the outputs (A and C) can be driven in hardware PWM mode, allowing high efficiency control of motor speeds, lamp brightness etc.

Each output can drive loads referenced to 0V, or to the positive supply voltage, or to another output (bridged connection). Bridged connection allows isolated loads, like many d.c. motors, to be driven bi-directionally.



Transistor outputs

Altering output status with Flowcode

The MIAC component within Flowcode has macros which allow users to directly adjust the status of the relay and transistor outputs. These can also be altered using the standard Output icon within Flowcode

Due to the internal allocation of microcontroller I/O for specific system functions, the external I/O is made up of individual pins from several ports as can be seen in the tables below:

RELAY OUTPUTS	
MIAC OUTPUT	MICROCONTROLLER PIN
Q1	RB4
Q2	RB5
Q3	RB6
Q4	RB7

TRANSISTOR OUTPUTS	
MIAC OUTPUT	MICROCONTROLLER PIN
A	RC2
B	RC0
C	RC1
D	RC6

Using Pulse Width Modulation (PWM)

Two of the transistor outputs (A and C) can be configured to operate under the control of hardware PWM signal generators.



PWM functionality for the A and/or C output(s) can be included in a Flowcode program by adding the standard Flowcode PWM component. Please refer to the Flowcode PWM documentation and help files for further information on the configuration and use of this component.

Controlling PWM using other compilers can be achieved by writing to the relevant PIC registers - see the datasheet on the 18F4455 for details.

PWM channel 1 = Transistor output A
PWM channel 2 = Transistor output C

Operator interface

The operator interface consists of:

- A status LED for each input.
- A status LED for each output.
- An indicator LED for the power supply.
- An indicator LED for the USB port.
- A 16 x 4 character LCD
- A 9-key keypad.

LED indicators

The input and output LEDs indicate the logic level present on their associated terminals. An input LEDs state is not valid when its input is being read as an analogue value. A LED could be weakly lit and yet not at a 'high' level. The need for the LED to indicate analogue voltage dictates this.

The POWER LED is driven by the internal logic supply and indicates that both the power and logic supplies are present. The USB LED is illuminated when a USB connection is present, and will flash to indicate activity on the USB port.

Keypad

The keypad consists of 9 keys. None of the keys have any specific software functions assigned to them, but are physically arranged to represent a range of frequently used operations:

- 4 cursor control/navigation buttons arranged in a circle.
- An OK (enter/select) button in the middle of the cursor keys.
- 4 function keys, individually coloured for ease of identification and referencing from the LCD.
- 2 of the function keys have been allocated useful icons (MENU and Go Back/Undo)
- 2 of the function keys are coloured red and green to represent STOP & START or ON & OFF controls. These are assigned the icons 'F1' and 'F2' implying Function 1 and function 2.

Using the keypad in Flowcode

Key	Icon	Value
Cursor centre	OK	4
Cursor up		5
Cursor down		3
Cursor left		1
Cursor right		7
Green	Menu	8
Red	Undo	6
Yellow	F1	2
Blue	F2	0

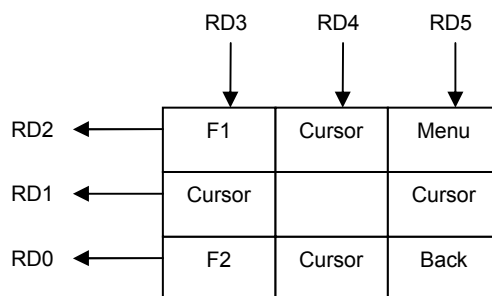
Key values returned by GetKeypad function

Within Flowcode the MIAC component includes macros for returning the number of the key pressed as can be seen in the table. The user program can

freely define the functions allocated to each key, and the way the keypad interacts with the LCD.

Using the keypad with programs other than Flowcode

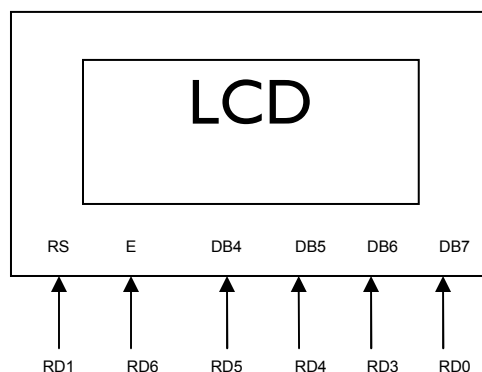
The keypad configuration is a standard 'output rows, scan columns' device And is connected as a 3 x 3 matrix.



Keypad block diagram

The LCD applies weak pull-ups to the shared connections, so the keypad has been configured for active low column selection. A low level on any of the row connections indicates a corresponding key press in the selected column.

LCD



LCD connections

The LCD is a general purpose alpha-numeric display consisting of 4 lines of 16 characters. It is fully accessible by programs running on the MIAC, and is supported in Flowcode by functions supplied as part of the MIAC component. The LCD E (Enable) signal is driven separately and allows the LCD to respond only to data intended for it. The display must be set to 4-bit data mode. The LCD R/W signal is connected to 0V (write mode) so data can not be retrieved from the display. The display is an SC1604A which uses a Samsung KS0066 controller and is compatible with the industry standard Hitachi HD44780 interface.

CAN bus interface

CAN (Control Area Network) is a standard serial communications bus used widely in both automotive and industrial applications. This bus can be used to network multiple MIAC units, and to communicate with other CAN equipped devices.

Each MIAC contains all the hardware necessary to operate as a CAN node. Successful transmission at high speed, and over long distances, requires good wiring practices to be observed:

- Suitable twisted pair cable should be used.
- Branches to individual nodes must be kept as short as possible so the CAN bus has definite start and end nodes.
- Terminating resistors should be fitted at the start and end of the bus.

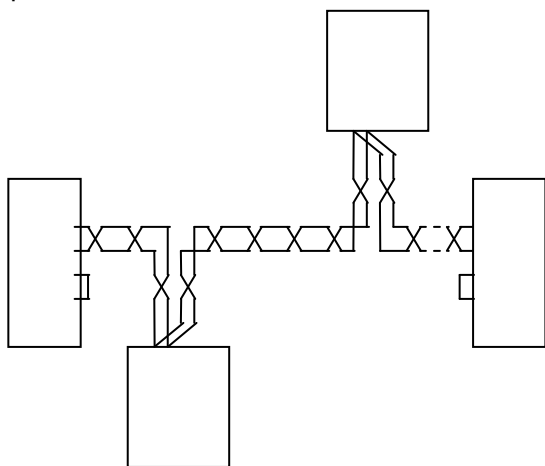
Each MIAC contains an internal terminating resistor that can be included in the CAN bus connections by adding a link between the TA and TB terminals.

CAN software functionality is included in a MIAC flowchart by adding the standard Flowcode CAN component:



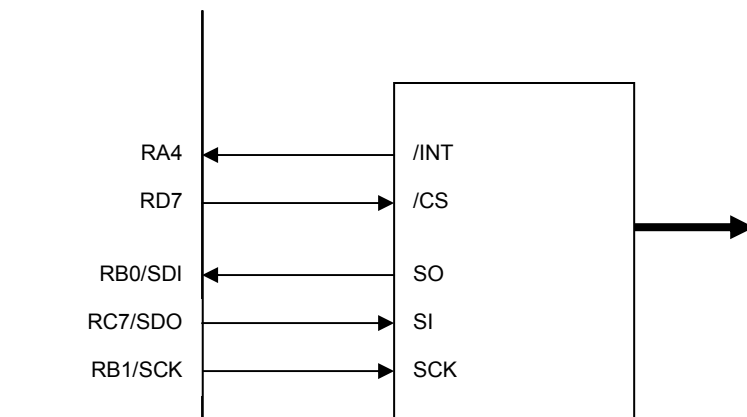
Please refer to the Flowcode CAN documentation and help files for further information on the configuration and use of this component.

CAN offers the advantages of fast data transfer, long transmission lengths, high immunity from electrical noise, and the ability to support multiple devices sharing the same connections - making networks relatively simple to create.



CAN bus wiring

The CAN bus is controlled by an MCP2515 CAN controller chip. The PIC communicates with it via its SPI peripheral hardware using the pins shown in the diagram. The output from the MCP2515 is fed into a CAN line driver chip and then fed to the CAN-H and CAN-L lines on the MIAC. Microchip provide plenty of information on driving the CAN bus in the MCP2515 datasheet if a development tool other than Flowcode is to be used

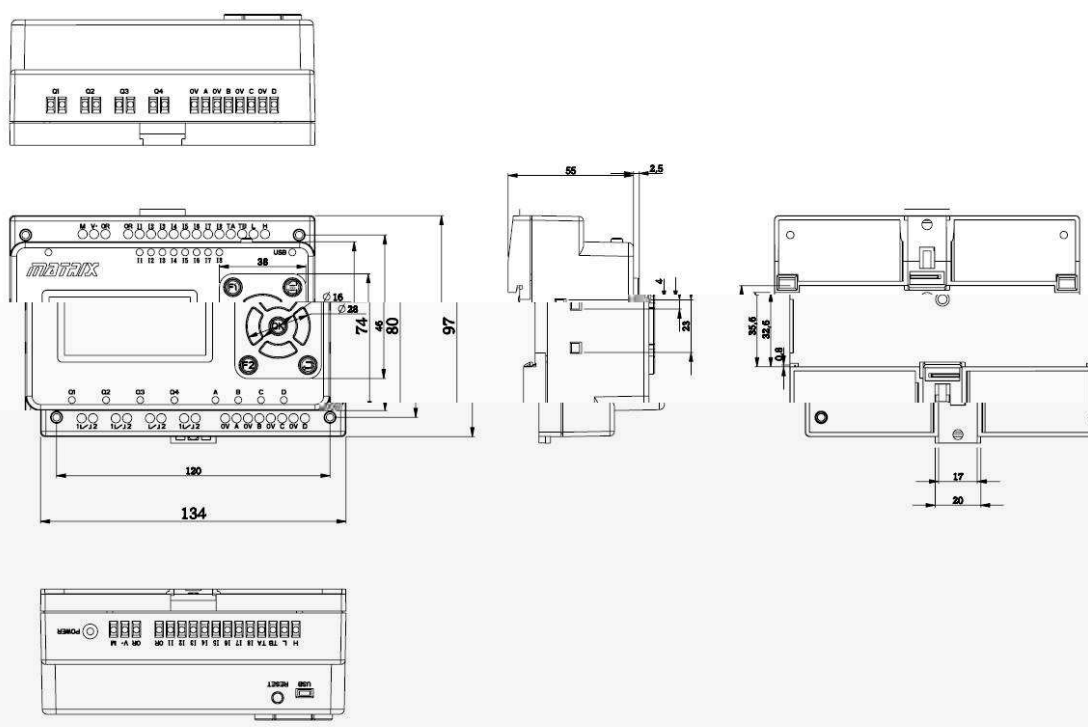


Technical specification

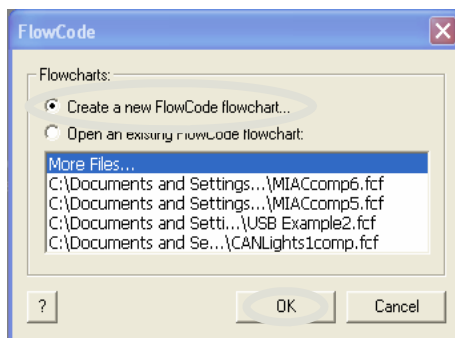
Power supply	12 - 16V DC, <2A
Inputs	8
Inputs usable as analogue inputs	8 - 0 to 12V DC
Analogue input sensitivity	10mV
Input impedance	10kΩ
Input Voltage Low	0V – 3V
Input Voltage High	>7.5V
Max input voltage range	-30V, +45V
Relay outputs	4
Relay output ratings	8A at 240VAC, 30VDC
Transistor outputs (source and sink)	4
Transistor output (per channel)	+/- 500mA
Max transistor output - all channels	+/- 1.75A
Transistor thermal shutdown	> +/- 500mA
PWM outputs, sensitivity	2 (A & C outputs), 0.4%
Power supply	12/16V DC at 100mA
Storage temperature	-40 to +70C
Transistor supply voltage (M)	6 - 28V DC, 4A
Operating temperature	-5 to 50C
Programming interface	USB
Processor	PICmicro 18F4455, 12K ROM, 2K RAM @48MHz
CAN bus processor	MCP2515 @20MHz

Ordering codes

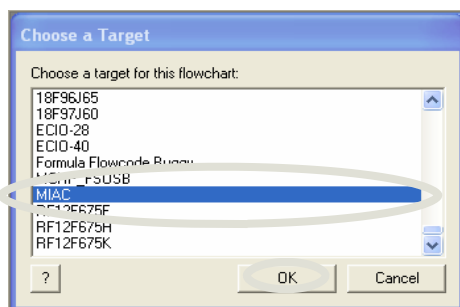
MIAC with Flowcode 3	MI0235
MIAC & 4mm shrouded sockets with Flowcode 3	MI0245
1A international power supply	HP5328
Flowcode 4 Professional	TEFLCSI4



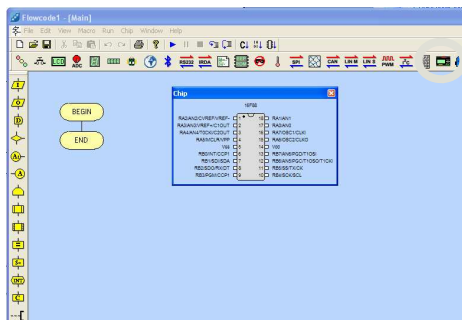
Programming example



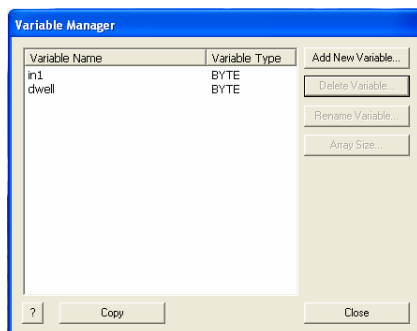
Start Flowcode and select the 'Create a new flowcode flow-chart' option



Select **MIAC** as the target device



Select the MIAC component from the Flowcode component bar



Use the 'Add New Variable...' button in the Edit -> Variables menu to create the two 'byte' variables required by the program.

Create the following timer relay example program by dragging the appropriate icons from the toolbar.

