FLEX

Modular solution for embedded applications

About Evidence S.r.l.

Evidence is a spin-off company of the ReTiS Lab of the Scuola Superiore S. Anna, Pisa, Italy. We are experts in the domain of embedded and real-time systems with a deep knowledge of the design and specification of embedded SW. We provide embedded firmware based on the Erika Enterprise RTOS for small single and multicore microcontrollers, custom Embedded Linux distributions for dedicated hardware, and a configuration and schedulability analysis tool named RT-Druid.

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About Embedded Solutions S.r.l.

Embedded Solutions is an Italian company specialized in hardware and software design. Embedded Solutions develops electronic devices based on microprocessor and microcontroller architectures, and it offers the possibility of having not only the hardware and software design of a product, but also the prototyping of multilayer boards with SMT and PTH technologies. The application fields covered by Embedded solutions starts from small applications with 8 bit microcontrollers, up to complex applications involving 32 bit general purpose microprocessors.

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Contents

1 Introduction

FLEX is an embedded board which can be used by all the developers who want to fully exploit the potential of the latest Microchip micro-controllers: the dsPIC (R) DSC family.

FLEX is born as a development board where to easily develop and test real-time applications for the Microchip dsPIC (R) DSC micro-controller. The main features of FLEX are:

- robust electronic design (e.g., FLEX Full includes a switching power supply);

- modular architecture (done by using daughter boards);

- availability of a growing number of application notes;

- the full support of the Erika Enterprise real-time kernel from Evidence Srl;

- availability of a code generator which is able to generate C code from a Scilab/Scicos design.

The compact and essential design allows the employment of FLEX not only for development purposes, but they make the FLEX platform a suitable solution for the direct deployment into the working environment such as into the following application scenario:

- Protocol converters;

- Minimal web servers;

- Acquisition systems;

- Wireless systems;

- Digital control systems.

2 The producers of the FLEX boards

The FLEX platform is the result of the synergetic effort of two italian companies working in the field of embedded systems: Evidence Srl and Embedded Solutions Srl.

The two companies combined their skills, respectively on real-time systems and electronic boards development, to create this complete, easy-to-use, compact solution for creating complex applications based on the Microchip dsPIC (R) DSC micro-controller.

In particular,

- Evidence Srl provided a GPL version of the Erika Enterprise RTOS including template applications for the FLEX boards.

- Embedded Solutions Srl provided the hardware design and is also is the producer of the FLEX hardware.

In addition to the availability of a set of daugther boards, it is possible to make custom daughter boards. If you are interested in customizations of the FLEX hardware, please check Chapter 4.

3 Architecture

The modular architecture provided by FLEX allows to compound a number of boards to integrate different features into a single device.

The basic configuration of a FLEX device is made by the Base Board only. The FLEX Base Board mounts a Microchip dsPIC (R) DSC micro-controller, and exports almost all the pins of the micro-controller. The user can easily connect the desired components to the dsPIC (R) DSC ports in order to build the specific application.

As depicted in Figure 3.1, several daughter boards can be connected in piggyback to the FLEX Base Board. The daughter boards have different features and they can be easily combined to obtain complex devices. Evidence S.r.l. and Embedded Solutions S.r.l. supplies a growing number of daughter boards for basic and advanced applications.

3.1 Base board

The FLEX Base Board is designed to export all the connections of a standard Microchip dsPIC (R) DSC micro-controller. The board connections use the standard 2.54 mm pitch: this feature make it easy the usage of custom, home-made daughter boards.

The board have two options for using onboard dsPIC (R) DSC micro-controllers: dsPIC (R) DSC controller welded on the board surface, and a socket for installing the micro-controller through the interchangeable Plug-In Modules (PIMs) available from Microchip. The availability of the latter option allows the developer to forget any limit on the number of programming cycles during the implementation/test/debugging phases: a new PIM can be installed on the socket in case of any problem to the older one.

The FLEX Base Board is available in two versions:

- Full version, showed in Section 3.1.1;

- Light version, showed in Section 3.1.2.

The connectors are fully compatible between Full and Light Versions, so that an application developed with the Full Version can be easily moved to the Light Version and vice-versa, i.e., without any modification to the control program.

3.1.1 Base board: Full version

The Full FLEX Base Board, depicted in Figure 3.3, integrates an extra-robust power supply circuitry, which allows the usage of a wide range of power suppliers.

It accepts voltage ranges between 9 - 36 V. The power supply signal is filtered and adapted to the internal levels. Figure 3.4 shows a rear view of the Flex Full board. on
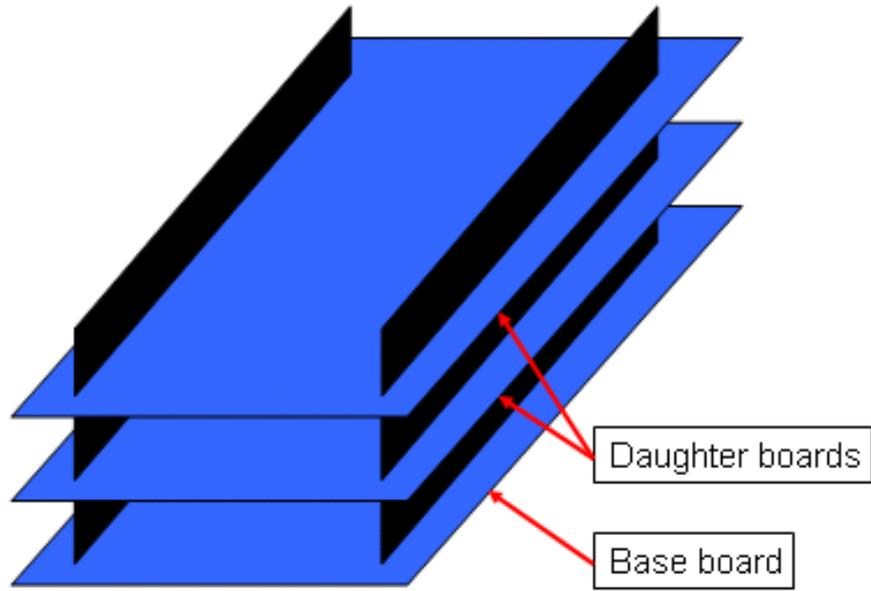
Figure 3.1: Piggybacked structure of FLEX boards.
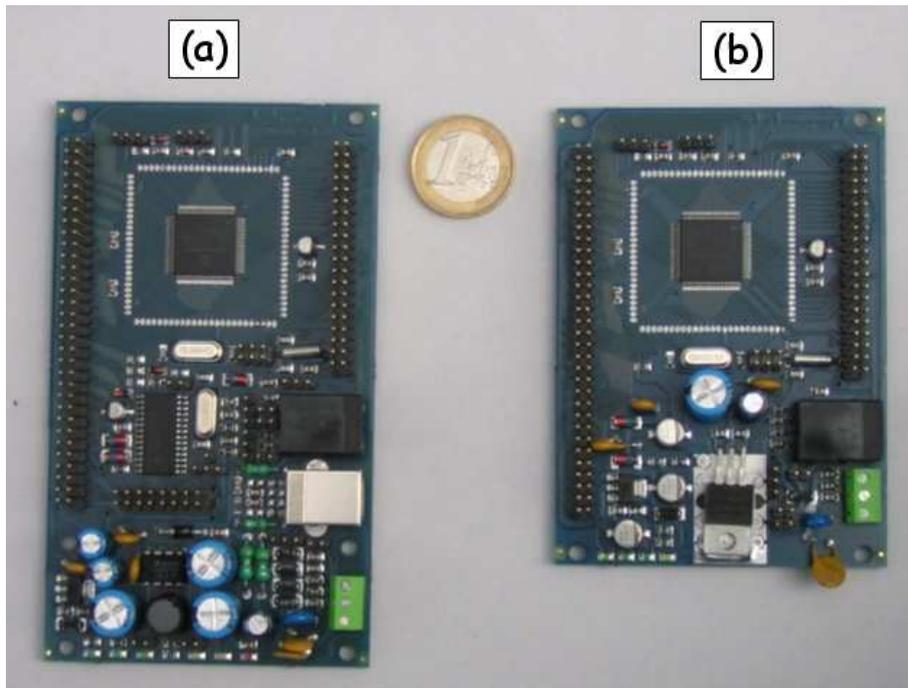
Figure 3.2: FLEX Full (a) and Light (b) versions.
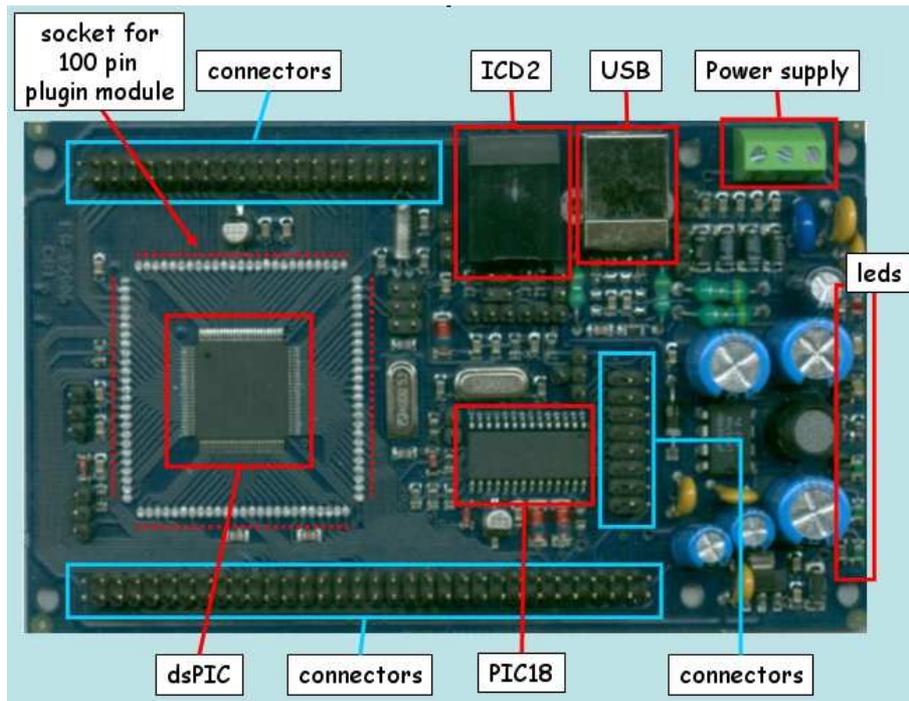
Figure 3.3: FLEX Full version.

the top right, there are the power supply connector. Connect the voltage to the first two pins, named in figure as VINA and VINB. You can connect DC and AC sources, regardless of the polarity.

The Full FLEX Base Board also natively includes an USB port that can be used for data transfer and, much more important, as a programming interface for the onboard dsPIC (R) DSC. This option allows to save the cost of the ICD2 programming device, making the whole development board self-contained.

> **Warning:** Please note that the debugging functionality on the PIC18 is not yet available. An application note will be available soon with all the needed information on how to implementthe programmer functionality on the PIC18. The debugger functionality will be available as special version of the FLEX Full.

The main components of Full FLEX Base Board, depicted in Figure 3.3, are:

- the Microchip dsPIC (R) DSC micro-controller;

- the socket for the 100 pin Plug-In Module (PIM) available from Microchip;

- the ICD2 programmer connector;

- the USB connector for direct programming;

Figure 3.4: Rear view of the FLEX Full version, with highlighted power supply pins (original photo courtesy of Sparkfun).

Figure 3.5: Mechanical dimensions of the FLEX Full version.

Led	Color	Function
DL1	green	Input power supply
DL2	green	internal +5V power line activity
DL3	green	internal +3V power line activity
DL4	yellow	dsPIC (R) DSC controlled led (e.g., debugging purposes)
DL5	yellow	internal PIC18 controlled led
DL6	red	USB cable connection monitor

Table 3.1: Available leds for the FLEX Full board.

- the power supply connectors;

- a set of leds for monitoring the board functioning status;

- the onboard Microchip PIC18 micro-controller for integrated programming;

- the set of connectors for daughter boards piggybacking.

The available leds are listed in Table 3.1. Please refer to Section 3.1.3 for an example on how to set these jumpers.

The available jumpers are listed in Table 3.2.

- JP3: allow to enable the input power monitoring leds of 5V and 3.3V before the switching circuitry;

- JP4: enables the dsPIC (R) DSC controlled system led;

- JP5: allow to connect the logic GND line to PE;

- JP6: allow to use an external power supply instead of the internal 3.3V for the dsPIC (R) DSC A/D converters positive voltage;

- JP7: allow to use an external power supply instead of the internal 0V for the dsPIC (R) DSC A/D converters negative voltage;

- JP8: allows to toggle the voltage reference on the ICSP programming connector to be supplied to the ICD2 device between 5V and 3.3V;

- JP9: allow to switch the PIC18 power supply between the USB power line and the internal +5V power level;

- JP10: toggle the Master Clear signal coming from the ICSP programming connector between dsPIC (R) DSC and PIC18 micro-controllers;

- JP11: toggle the programming data line coming from the ICSP programming connector between dsPIC (R) DSC and PIC18 micro-controllers;
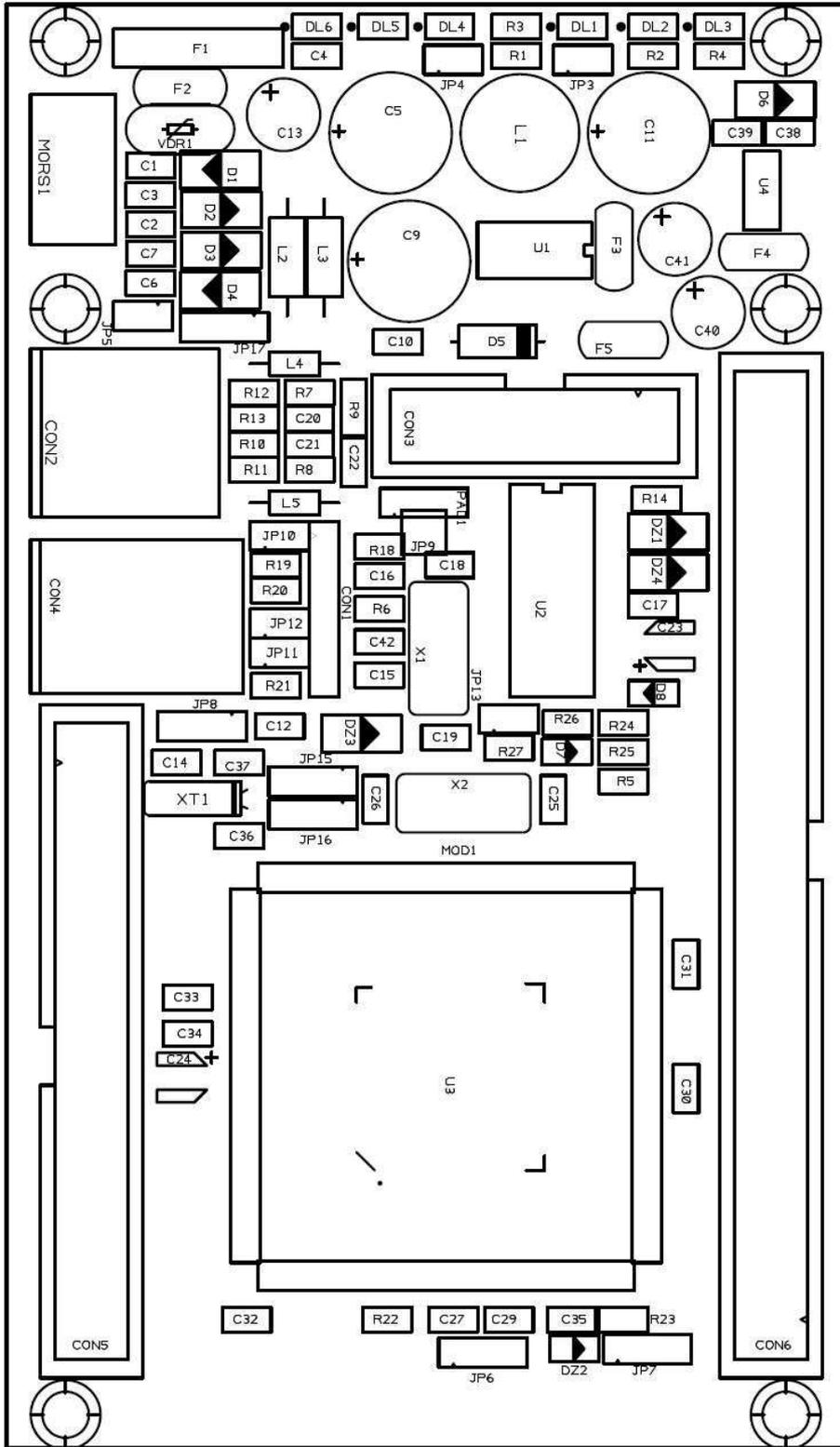
Figure 3.6: FLEX Full Printed Circuit Board.

Jumper	Function
JP3	Enable the power monitoring leds (closed)
JP4	Enable the dsPIC (R) DSC controlled led (closed)
JP5	Logical GND (closed) or PE selector (open)
JP6	External power supply selector for A/Ds (internal 3.3 V if in position 1-2)
JP7	External power supply selector for A/Ds (internal 0 V if in position 1-2)
JP8	voltage reference selector for the the ICSP programming connector (position 1-2, 5 V, position 2-3, 3.3 V)
JP9	PIC18 power supply selector (position 1-2, from USB, position 2-3, from internal power supply)
JP10	Master Clear signal switch between dsPIC (R) DSC (position 1-2) and PIC18 (position 2-3)
JP11	programming data line switch between dsPIC (R) DSC (position 1-2) and PIC18 (position 2-3)
JP12	programming clock line switch between dsPIC (R) DSC (position 1-2) and PIC18 (position 2-3)
JP13	optional RX serial port pull-up resistor (closed)
JP15, JP16	External Real-time clock (position 1-2)
JP17	USB shield to GND (position 1-2) or PE selector (position 2-3)

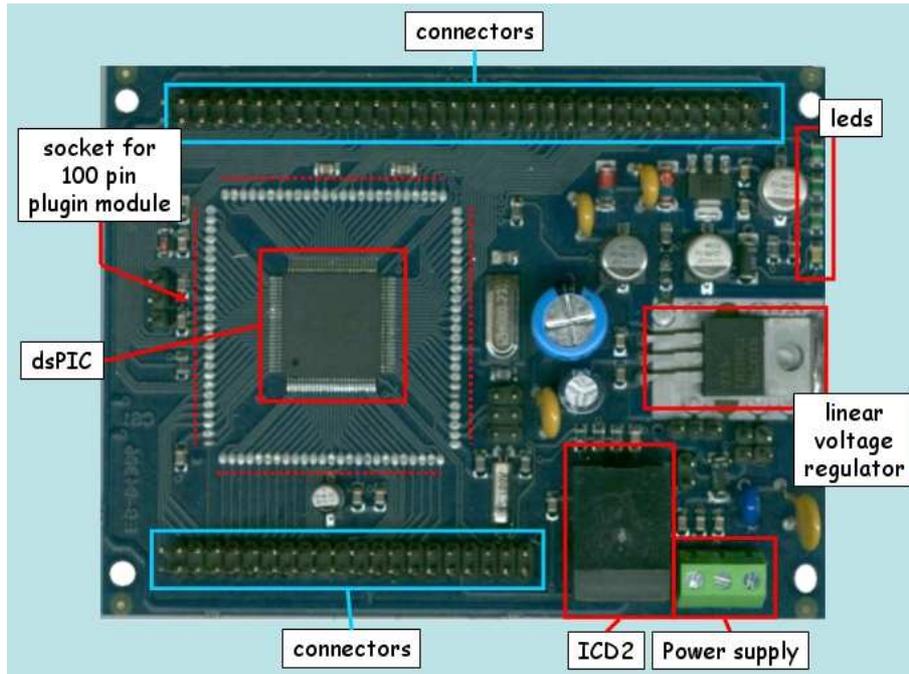Table 3.2: Available configuration jumpers for the FLEX Full board.

Figure 3.7: FLEX light version.

- JP12: toggle the programming clock line coming from the ICSP programming connector between dsPIC (R) DSC and PIC18 micro-controllers;

- JP13: connects the pull-up resistor to the RX serial line; if unused, the pin is used as a regular GPIO pin;

- JP15 and JP16: allows to use an external clock oscillator for the dsPIC (R) DSC; if disabled, the two pins are used as normal GPIO pins;

- JP17: allow to toggle the USB shield between GND or PE.

3.1.2 Base board: Light version

The Light FLEX Base Board, depicted in Figure 3.7, has been designed to be as compact as possible. The Light Versions uses a simplified power supply circuitry, and thus requires a more careful power supply than the Full Version. Moreover, there is no integrated USB programming capability. Examples of target applications for the Light FLEX Base Board are: distributed, battery-powered applications, like sensor networks; small robotic applications, i.e., for mobile robot control and sensor acquisition.

The power supply of the Light FLEX Base Board varies in the range of 9 - 12V DC. Figure 3.8 shows a rear view of the Flex Light board. On the top right, there are the power supply connector. Connect the source voltage to the first two pins, named in figure as V+ and V-.
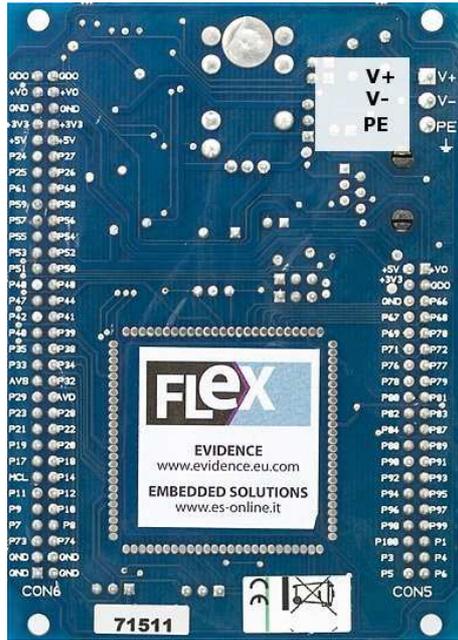
Figure 3.8: Rear view of the FLEX Light version, with highlighted power supply pins (original photo courtesy of Sparkfun).
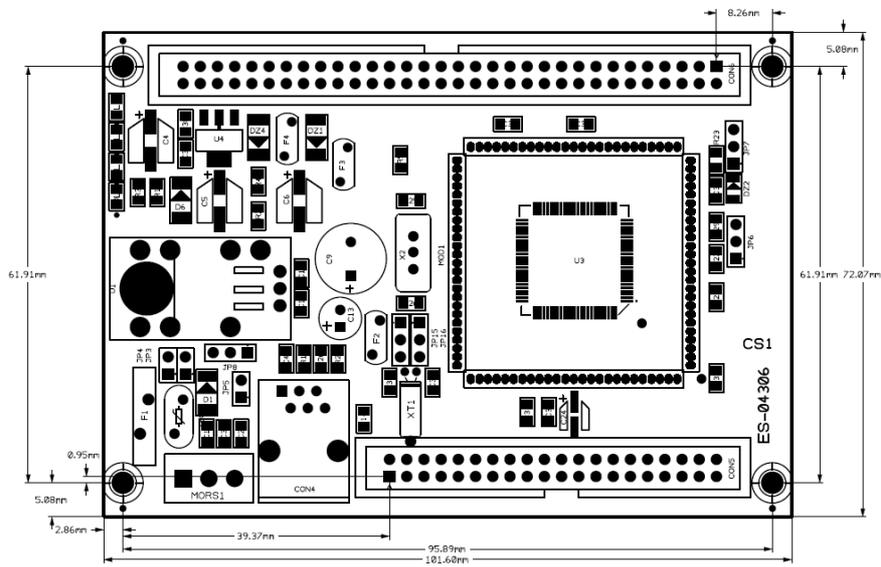

Figure 3.9: Mechanical dimensions of the FLEX Light version.

Jumper	Function
JP3	Enable the power monitoring leds (closed)
JP4	Enable the dsPIC (R) DSC controlled led (closed)
JP5	Logical GND (closed) or PE selector (open)
JP6	External power supply selector for A/Ds (internal 3.3 V if in position 1-2)
JP7	External power supply selector for A/Ds (internal 0 V if in position 1-2)
JP8	voltage reference selector for the the ICSP programming connector (position 1-2, 5 V, position 2-3, 3.3 V)
JP15, JP16	External Real-time clock (position 1-2)

Table 3.3: Available configuration jumpers for the FLEX Light board.

The available jumpers are listed in Table 3.3. Please refer to Section 3.1.3 for an example on how to set these jumpers.

- JP3: allow to enable the input power monitoring leds of 5V and 3.3V before the switching circuitry;

- JP4: enables the dsPIC (R) DSC controlled system led;

- JP5: allow to connect the logic GND line to PE;

- JP6: allow to use an external power supply instead of the internal 3.3V for the dsPIC (R) DSC A/D converters positive voltage;

- JP7: allow to use an external power supply instead of the internal 0V for the dsPIC (R) DSC A/D converters negative voltage;

- JP8: allows to toggle the voltage reference on the ICSP programming connector to be supplied to the ICD2 device between 5V and 3.3V;

- JP15 and JP16: allows to use an external clock oscillator for the dsPIC (R) DSC; if disabled, the two pins are used as normal GPIO pins;

3.1.3 Base board: Typical Jumper settings

This section contains three figures that shows some typical jumper settings for the FLEX base boards. Settings the jumpers in the correct way is important, because it allows you to control some important features of the board, which influences the power consumption and voltage settings of the board components. Please note that for the FLEX Full, there are two typical settings, depending if the user needs to program the dsPIC or the PIC18.
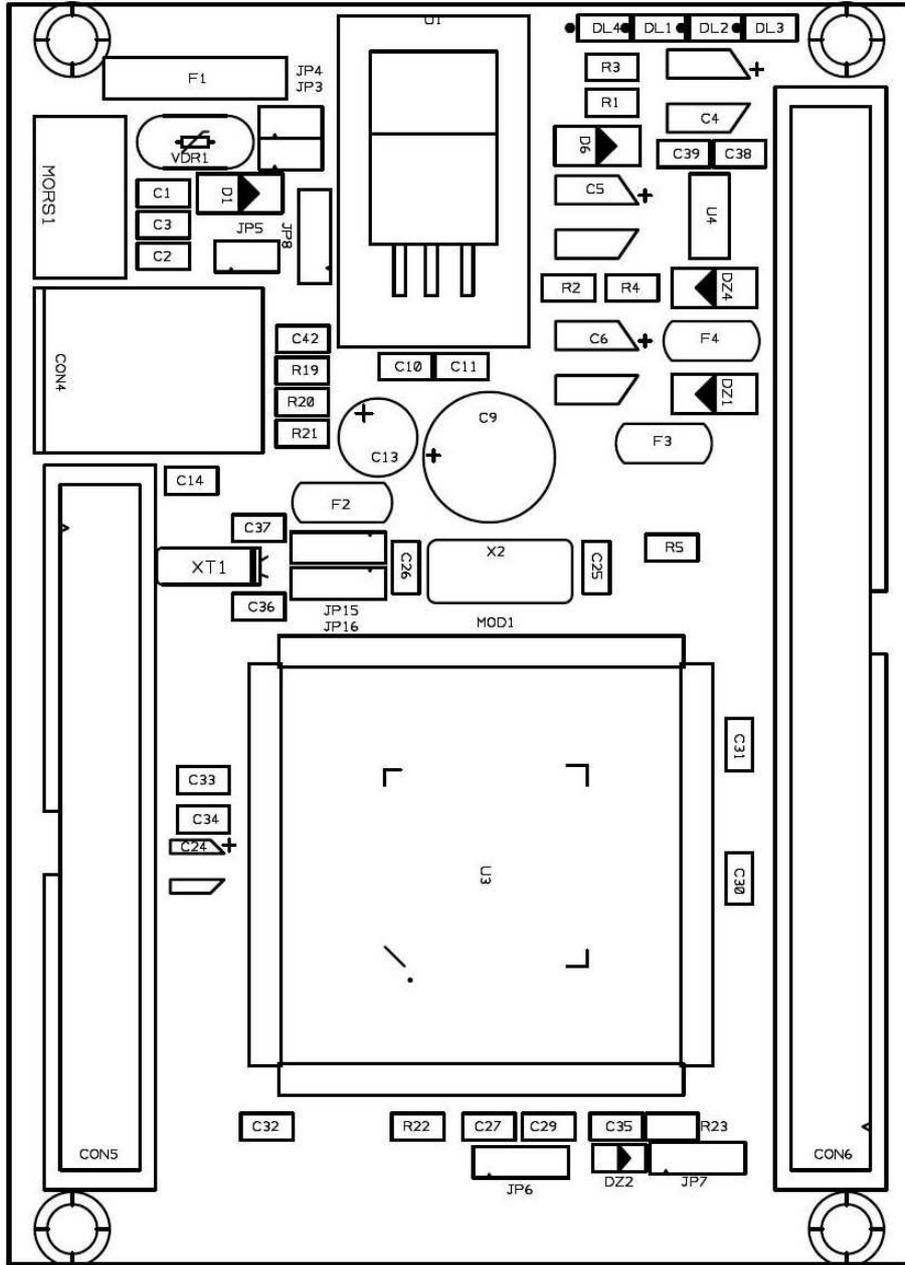
Figure 3.10: FLEX Light Printed Circuit Board.
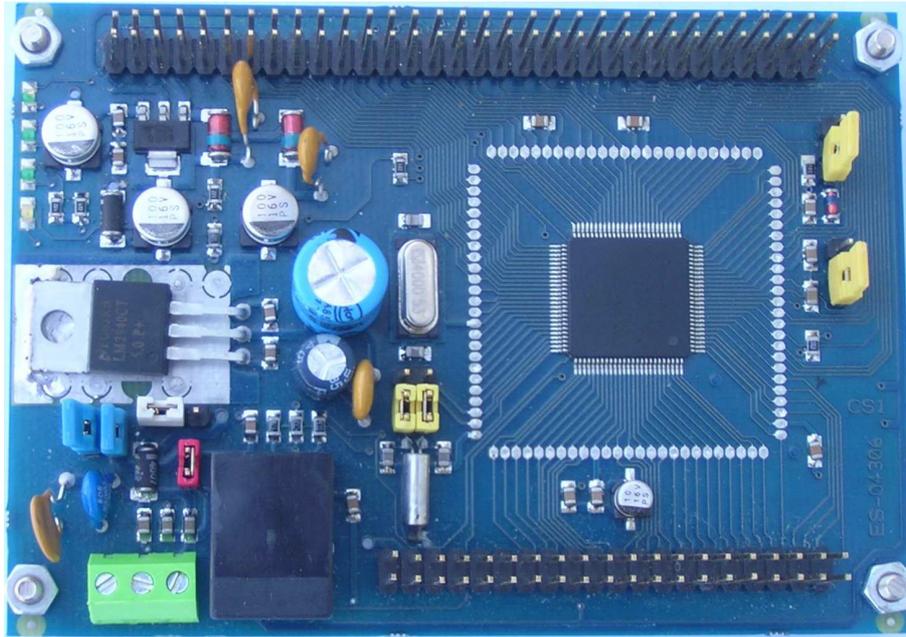
Figure 3.11: A typical jumper setting for the FLEX Light.

Programming the dsPIC on the FLEX **Light**

A basic settings for the jumpers for the FLEX Light is depicted in Figure 3.11. The Figure highlights the following jumper settings:

JP3 (closed) - the power monitor leds are on when there is power supply;

JP4 (closed) - LEDSYS will be controlled by the dsPIC.

JP5 (closed) - ground is connected to the PE reference;

JP6 and JP7 (1-2) - A/D converters use VDD and VSS as Vref+ and Vref-;

JP8 (2-3) - the voltage on the ICSP connector is 3.3 V;

JP15 and JP16 (2-3) - Real-Time Clock enabled.

Programming the dsPIC on the FLEX **Full**

A basic settings for the jumpers for the FLEX Full in the case the user wants to program the dsPIC is depicted in Figure 3.12. The Figure highlights the following jumper settings:

JP3 (closed) - the power monitor leds are on when there is power supply;

JP4 (closed) - LEDSYS will be controlled by the dsPIC.

Figure 3.12: A typical jumper setting for programming the dsPIC on the FLEX Full.

JP5 (closed) - ground is connected to the PE reference;

JP6 and JP7 (1-2) - A/D converters use VDD and VSS as Vref+ and Vref-;

JP8 (2-3) - the voltage on the ICSP connector is 3.3 V;

JP9 (2-3) - the PIC18 power supply selects the internal power supply;

JP10 (1-2) - the Master Clear signal is connected to the dsPIC;

JP11 (1-2) - the programming data line is connected to the dsPIC;

JP12 (1-2) - the programming clock line is connected to the dsPIC;

JP13 (open) - no RX serial port pull-up resistor;

JP15 and JP16 (2-3) - Real-Time Clock enabled;

JP17 (1-2) USB shield connected to GND.

Programming the PIC18 on the FLEX **Full**

A basic settings for the jumpers for the FLEX Full in the case the user wants to program the PIC18 is depicted in Figure 3.13. The Figure highlights the following jumper settings:

JP3 (closed) - the power monitor leds are on when there is power supply;

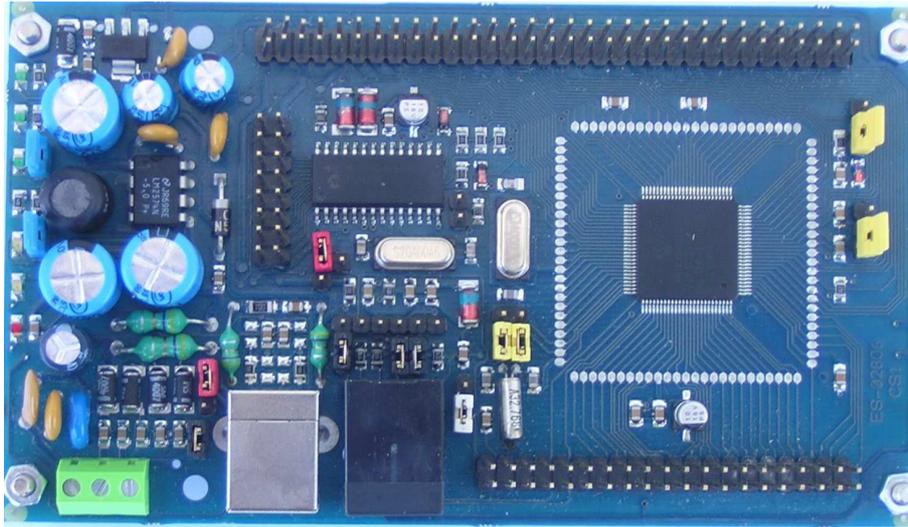**JP4** (closed) - LEDSYS will be controlled by the dsPIC.
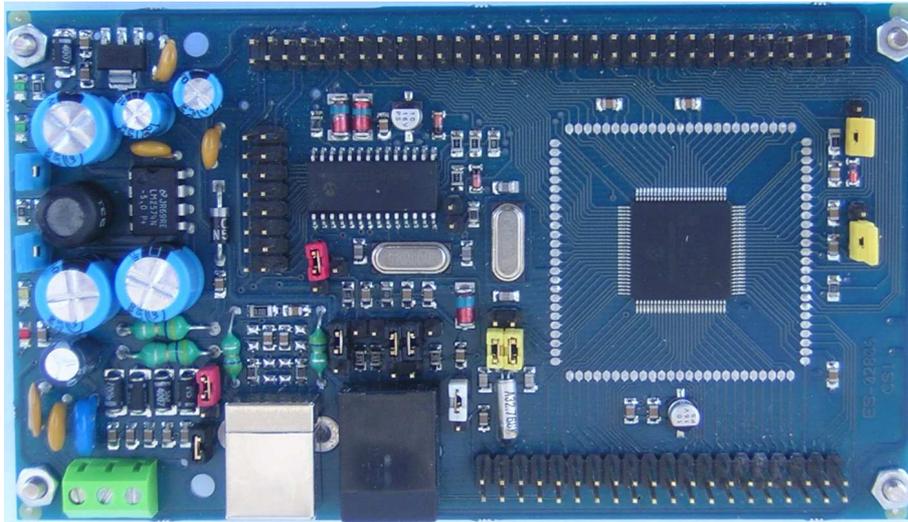
Figure 3.13: A typical jumper setting for programming the PIC18 on the FLEX Full.

JP5 (closed) - ground is connected to the PE reference;

JP6 and JP7 (1-2) - A/D converters use VDD and VSS as Vref+ and Vref-;

JP8 (1-2) - the voltage on the ICSP connector is 5 V;

JP9 (2-3) - the PIC18 power supply selects the internal power supply;

JP10 (2-3) - the Master Clear signal is connected to the PIC18;

JP11 (2-3) - the programming data line is connected to the PIC18;

JP12 (2-3) - the programming clock line is connected to the PIC18;

JP13 (open) - no RX serial port pull-up resistor;

JP15 and JP16 (2-3) - Real-Time Clock enabled;

JP17 (1-2) USB shield connected to GND.

3.2 FLEX **pinout mapping**

The next two tables shows the FLEX pinout mappings[1]

3.2.1 FLEX **CON5 mappings**

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[1]Thanks to Andrea Bertelli for the Latex tables!

Pin	CON5 Mappings
1	$Vout$
2	$5V\ out$
3	Gnd_{out}
4	$3V\ out$
5	$INT3/RA14$
6	Gnd
7	$IC1/RD8$
8	$INT4/RA15$
9	$IC3/RD10$
10	$IC2/RD9$
11	$OC1/RD0$
12	$IC4/RD11$
13	$OC3/RD2$
14	$OC2/RD1$
15	$IC5/RD12$
16	$OC4/RD3$
17	$OC5/CN13/RD4$
18	$IC6/CN19/RD13$
19	$OC7/CN15/RD6$
20	$OC6/CN14/RD5$
21	$C1RX/RF0$
22	$OC8/UPDNCN16/RD7$
23	$C2TX/RG1$
24	$C1TX/RF1$
25	$AN22/CN22/RA6$
26	$C2RX/RG0$
27	$PWM1L/RE0$
28	$AN23/CN23/RA7$
29	$CSCK/RG14$
30	$PWM1H/RE1$
31	$CSD0/RG13$
32	$CSDI/RG12$
33	$PWM2H/RE3$
34	$PWM2L/RE2$
35	$COFS/RG15$
36	$PWM3L/RE4$
37	$PWM4L/RE6$
38	$PWM3H/RE5$
39	$AN16/T2CK/T7CK/RC1$
40	$PWM4H/RE7$

3.2.2 FLEX **CON6 mappings**

Pin	CON6 mappings
1	Gnd
2	Gnd
3	Gnd
4	Gnd
5	PGD2/EMUD2/SOSCI/CN1/RC13
6	PGC2/EMUC2/SOSCO/T1CK/CN0/RC14
7	AN17/T3CK/T6CK/RC2
8	AN18/T4CK/T9CK/RC3
9	AN19/T5CK/T8CK/RC4
10	SCK2/CN8/RG6
11	SDI2/CN9/RG7
12	SDO2/CN10/RG8
13	DSP_{MCLR}
14	SS2/CN11/RG9
15	TMS/RA0
16	AN20/FLTA/INT1/RE8
17	AN21/FLTB/INT2/RE9
18	AN5/QEB/CN7/CN7/RB5
19	AN4/QEA/CN6/RB4
20	AN3/INDX/CN5/RB3
21	AN2/SS1/CN4/RB2
22	$Vref-/RA9$
23	$Vref+/RA10$
24	$AVDD_{ext}$
25	$AVSS_{EXT}$
26	AN8/RB8
27	AN9/RB9
28	AN10/RB10
29	AN11/RB11
30	TCK/RA1
31	U2CTS/RF12
32	U2RTS/RF13
33	AN13/RB13
34	AN12/RB12
35	IC7/U1CTS/CN20/RD14
36	AN15/OCFB/CN12/RB15
37	U2RX/CN17/RF4

38	IC8/U1RTS/CN21/RD15
39	U1TX/RF3
40	U2TX/CN18/RF5
41	SDO1/RF8
42	U1RX/RF2
43	SCK1/INT0/RF6
44	SDI1/RF7
45	SCL1/RG2
46	SDA1/RG3
47	SDA2/RA3
48	SCL2/RA2
49	**TD0/RA5**
50	TDI/RA4
51	PGD3/EMUD3/AN0/CN2/RB0
52	DSP_{PCLK}
53	PGC3/EMUC3/AN1/CN3/RB1
54	DSP_{PDATA}
55	$5V_{out}$
56	$5V_{out}$
57	$3V_{out}$
58	$3V_{out}$
59	Gnd
60	Gnd
61	V_{out}
62	V_{out}
63	GND_{out}
64	GND_{out}

3.3 Daughter boards

A FLEX Daughter Board is a board with specialized features that can be inserted on top of a FLEX Base Board (piggybacking) or connected another Daughter Board, to obtain complex devices for all possible applications.

Evidence S.r.l. and Embedded Solutions S.r.l. propose a set of general purpose Daughter Boards for some most common applications.

The development of custom, home-made daughter boards is made easy since the FLEX Base Board connectors use the standard 2.54 mm pitch. Therefore, the features of the FLEX platform can be extended with virtually no limits.
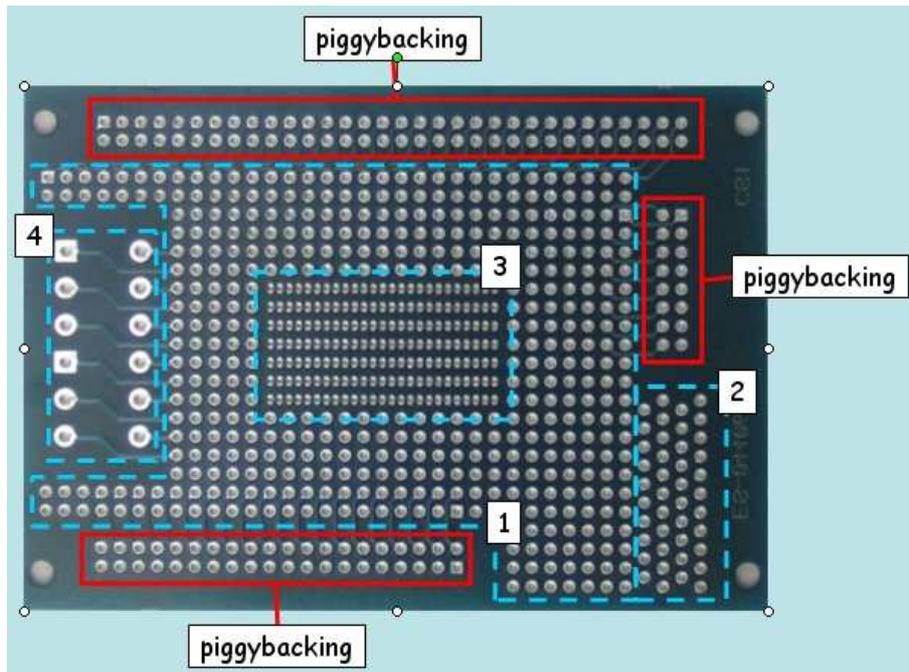
Figure 3.14: Thru Hole board.

3.3.1 Thru Hole board

The board depicted in Figure 3.14 is targeted to the development of small, homemade, custom circuits that can be transparently interfaced with the FLEX Base Boards.

The board makes several common pinholes available to the user, for connecting electronic components.

Patterns marked with "piggybacking" are pins which come from the piggybacked FLEX board. As can be seen in Figure 3.14, each pin on the piggybacking rows is connected to a pin on the most wide board section. The remaining board surface is divided into the most common pinhole patterns, such as:

1. standard 2.54 mm pattern;

2. standard 2.54 mm pattern with alternate phases, useful for, i.e., RJ45 and RS232 connectors, etc.;

3. standard 1.27 mm pattern, useful for connecting typical SMD components;

4. standard 5.08 mm pattern, useful for, i.e., clamps;

3.3.2 Multibus

The Multibus board has been developed with the goal of providing various communication possibilities to the FLEX boards. The main idea of the Multibus board is to provide
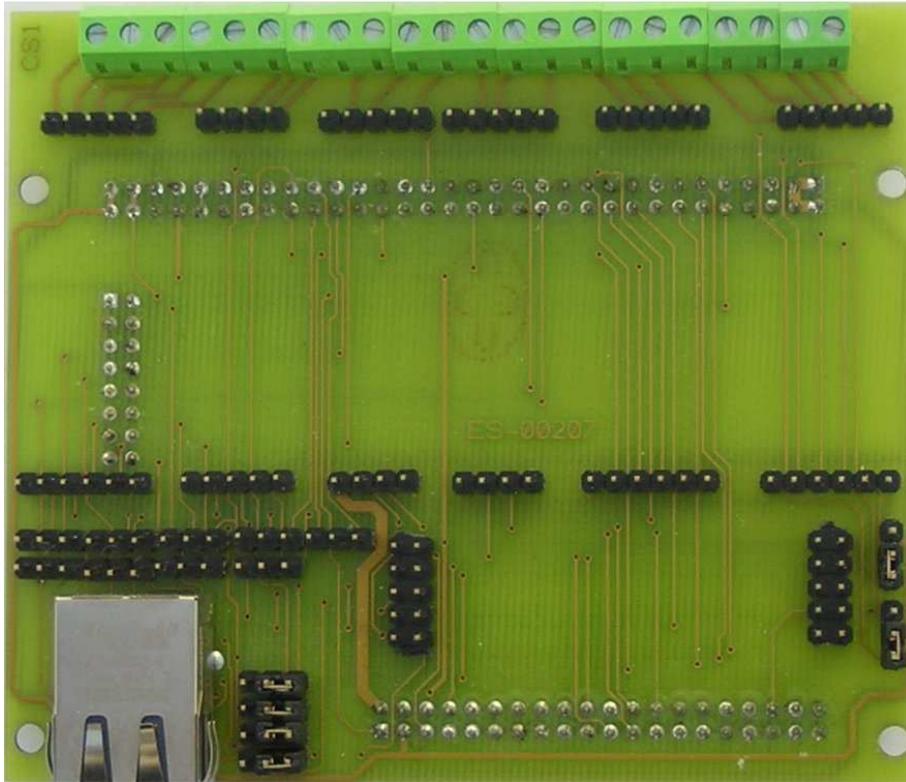
Figure 3.15: A photo of the Multibus base board (the color of the production board is blue).

a base board where different communication modules can be plugged in, to adapt the communication available on the board to the application requirements. The Multibus board provides the transceivers to the most common interfaces available on the dsPIC chip, like serials, SPI, CAN I2C, as well as additional enhancements like the ethernet port.

The Multibus daughter board is composed bye a base board (see Figure 3.15) which has to be plugged on top of a FLEX Light or a FLEX Full by using the connectors on the FLEX boards. The base board contains a set of jumpers which are needed to configure the different communication devices, as well as a set of "slots" for plug-in modules, and a set of clamps for the connection to the communication buses.

Figure 3.16 shows the multibus board mounted on a FLEX board. In the figure, numbers 1 and 2 are serial modules, 3 and 4 are CAN modules, 5 is left empty, 6 is an SPI module, 7 and 8 are the ethernet modules and connector. Please note that the Ethernet connector is typically not mounted on the Multibus base board.

Figure 3.17 shows the location of the various plugin modules to simplify the placing of the various modules.

The following plug-in modules are available to the final user:
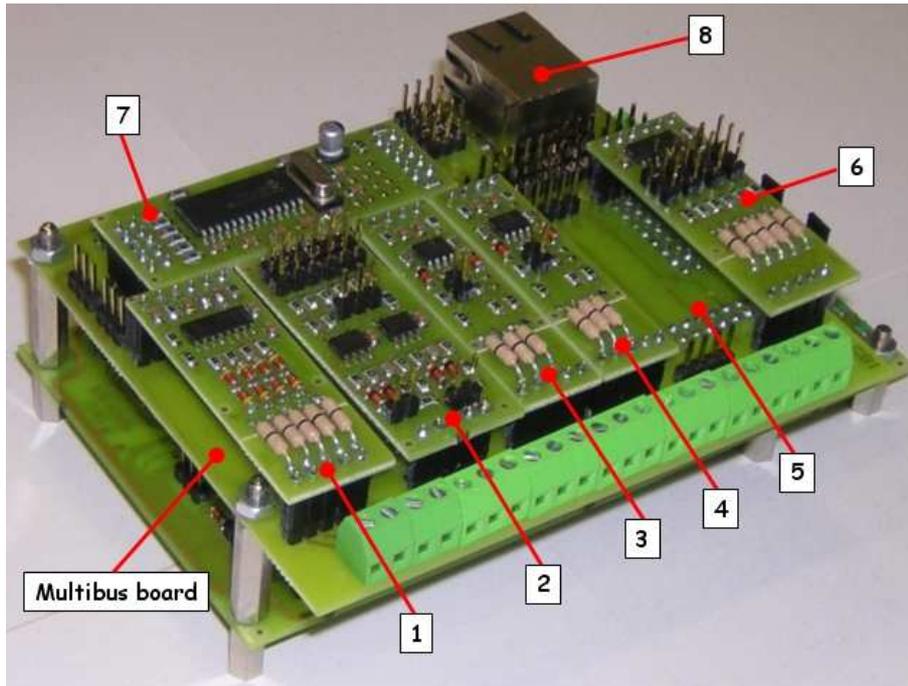
- UART TTL (see Subsection 3.3.2);

Figure 3.16: A photo of the Multibus board over a FLEXboard.

- RS232 (see Subsection 3.3.2);

- RS422 (see Subsection 3.3.2);

- RS485 (see Subsection 3.3.2);

- I2C (see Subsection 3.3.2);

- SPI (see Subsection 3.3.2);

- CAN (see Subsection 3.3.2);

- TP-UART (see Subsection 3.3.2);

- Ethernet (see Subsection 3.3.2);

Table 3.6 shows the various ways in which the various modules can be connected to the board modules.

Multibus base board jumpers

The Multibus base board hosts a set of jumpers which are needed to set-up some the plug-in modules. These jumpers are typically used to select which peripherals among those available on the dsPIC (R) DSC should be connected to the module on the board.
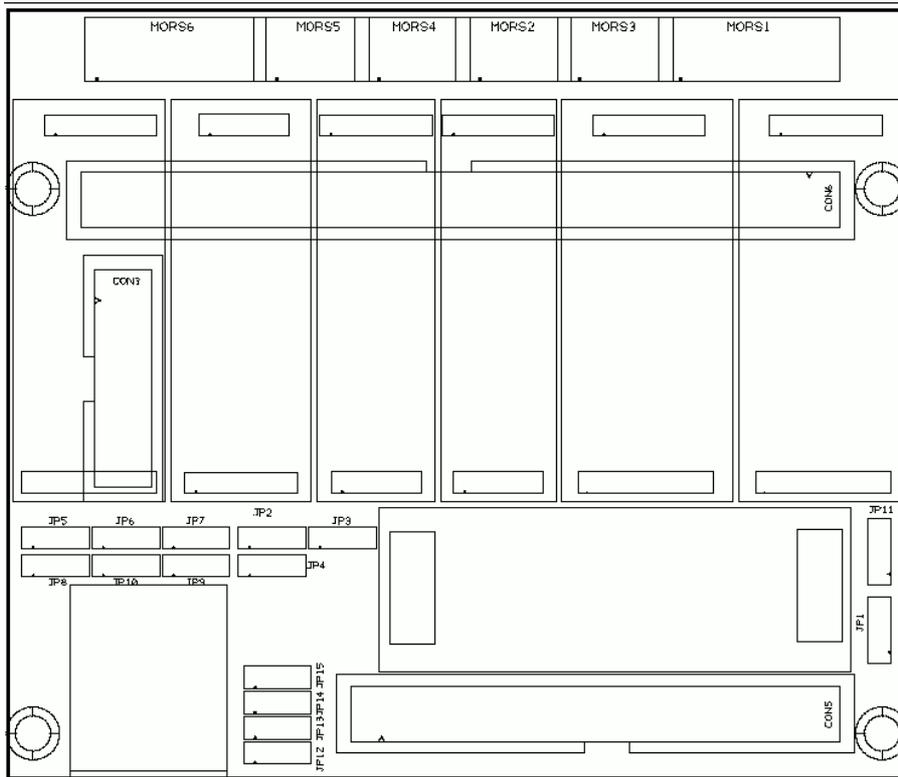
Figure 3.17: The jumpers and modules layout of a Multibus base board.

Module	Slot					
	1	2	3	4	5	6
TTL Uart	√	√				
RS232	√	√				
RS485	√	√				
RS422	√					
TP-Uart	√					
CAN			√	√		
I2C					√	
SPI						√

Table 3.6: This table shows the various ways the modules can be connected in the multi-bus board.

Figure 3.18: The figure shows the jumper settings for the SPI chip select of Slot 6.
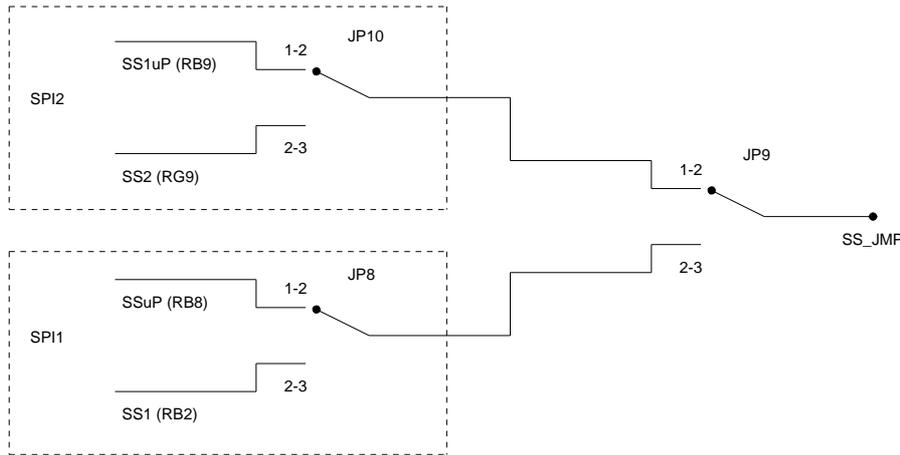
Slot 1 - JP1 Jumper JP1 is used to control a pin of the module hosted on Slot 1. In particular, in position 1-2 a pin of the module is connected to FRCK1 (used for serial communications with flow control), whereas in position 2-3 it is connected to the pin RESN (used to handle the input interrupt pin for the TP-UART module).

Slot 1 - JP11 Jumper JP11 selects whether the ground reference to the module should be given filtered (position 1-2) or not filtered (position 2-3).

Slot 5 - JP2, JP3, JP4 Jumpers JP2, JP3 and JP4 are used to select if the data, clock and chip select pins of the I2C bus should be connected to the first (position 2-3) or second (position 1-2) I2C peripheral of the dsPIC. Please note that all the three jumpers should select the same port (that is, they must be all three in position 1-2 or 2-3).

Slot 6 - JP5, JP6, JP7, JP8, JP9, JP10 Jumpers JP5, JP6, JP7 can be used to selectif the data in, data out, and clock of the SPI bus should be connected to the first (position 2-3) or to the second (1-2) SPI peripheral of the dsPIC (R) DSC. Please note that all the three jumpers should select the same port (that is, they must be all three in position 1-2 or 2-3).

Jumpers JP8, JP9, and JP10 control the chip select of the SPI module from either a general purpose I/O or chip select pin built-in in the microcontroller (see Figure 3.18 and Table 3.7).

Slot 7 - JP12, JP13, JP14, JP15 Jumpers JP12, JP13, JP14 and JP15 can be used to selectif the data in, data out, clock and chip select of the Ethernet bus should be connected to the first (position 2-3) or to the second (1-2) SPI peripheral of the dsPIC (R) DSC. Please note that all the four jumpers should select the same port (that is, they must be all four in position 1-2 or 2-3).

JP9	JP8	JP10	Chip select from
1-2	x	1-2	RB9
1-2	x	2-3	SS2(RG9)
2-3	1-2	x	RB8
2-3	2-3	x	SS1(RB2)

Table 3.7: The table shows the jumper settings for the SPI chip select of Slot 6.

Multibus base board connectors

The Multibus base board exports the outputs of each module using a set of clamps which are located on one side of the board (in Figure 3.17, they are named MORS1 to MORS6). The only exception is the ethernet module, which directly communicate using the RJ45 connector which is located on the board (please note that the connector is not solded on the board by default).

The following paragraphs describe the meaning of the connectors, in the order they appear in Figure 3.17.

Connector 1 (MORS1) Is a 5 pin connector which can be used for the serial lines connected using the first serial module. The various pins have a different meaning depending on the serial module which is hosted on the board. In particular:

- If the TTL UART or RS232 module is connected, the meaning of the five pins is the following: 1 - CTS; 2 - RX; 3 - TX; 4 - RTS; 5 - GND;

- If the RS422 is connected, the meaning of the five pins is the following: 1 - 485+; 2 - 485-; 3 - 485+ (2); 4 - 485- (2); 5 - GND;

- If the RS485 module is connected, the meaning of the five pins is the following: 2 - 485-; 3 - 485+; 5 - GND;

- If the TP-UART module is connected, the meaning of the five pins is the following: 2 - A_TP; 3 - B_TP

Connector 3 (MORS3) Is a 3 pin connector which can be used for the serial lines connected using the second serial module. The various pins have a different meaning depending on the serial module which is hosted on the board. In particular:

- If the TTL UART or RS232 module is connected, the meaning of the five pins is the following: 1 - RX; 2 - TX; 3 - GND;

- If the RS485 module is connected, the meaning of the five pins is the following: 1 - 485-; 2 - 485+; 3 - GND;
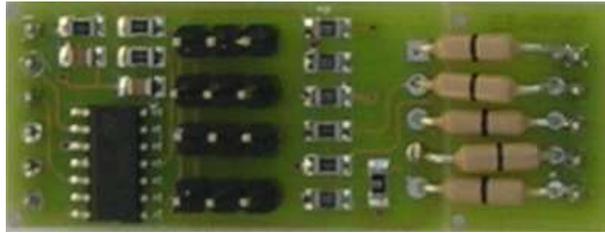
29

Figure 3.19: The UART TTL module.

Connector 2 (MORS2)   This is a connector which can be used to connect the peripherals to the first CAN module. The meaning of the various pins is the following: 1 - CAN+; 2 - CAN-; 3 - GND.

Connector 4 (MORS4)   This is a connector which can be used to connect the peripherals to the second CAN module. The meaning of the various pins is the following: 1 - CAN+; 2 - CAN-; 3 - GND.

Connector 5 (MORS5)   This is a connector which can be used to connect the peripherals to the I2C module. The meaning of the various pins is the following: 1 - Data; 2 - Clock; 3 - GND.

Connector 6 (MORS6)   This is a connector which can be used to connect the peripherals to the SPI module. The meaning of the various pins is the following: 1 - 1 - Data Out; 2 - Data In; 3 - Clock; 4 - Chip Select; 5 - GND.

UART TTL module

This module can be used to export the UART pins linked to the UART peipherals on the dsPIC by using signals which are compatible with TTL electronic equipments (see Figure 3.19). Moreover, the module has a set of components which are used to protect the microcontroller pins from input signals which are not compatible with the specifications.

The module has four jumpers named JP1, JP2, JP3 and JP4 which can be used to put in high impedance respectively the RX, CTS, TX and RTS signals. Figure 3.20 shows the module layout with the location of the various jumpers.

RS232 module

This module can be used to export the UART pins linked to the UART peipherals on the dsPIC by using signals which are compatible with the RS232 standard (see Figure 3.21).
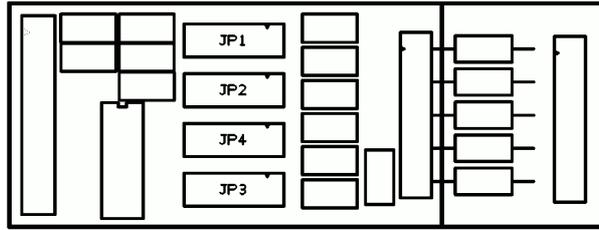
Figure 3.20: The UART TTL module layout.

Figure 3.21: The UART RS232 module.

RS422 module

This module can be used to export the UART pins linked to the UART peipherals on the dsPIC by using signals which are compatible with the RS422 specification (see Figure 3.22).

The module has three jumpers named JP1 to JP7 which can be used for the following purposes:

- JP2 and JP5 controls the termination of the two RS485 lines;

- (first RS485 line) JP3 in position 1-2 enables the reception (RX) from the signal TXEN of the microcontroller (0 = ON); in position 2-3 enables the reception; if open disables the RX.
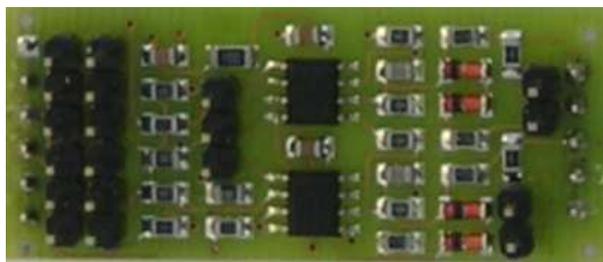
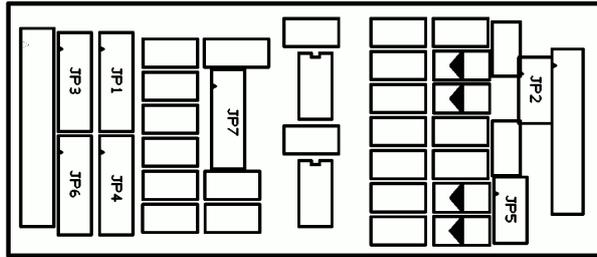

Figure 3.22: The UART RS422 module.

Figure 3.23: The UART RS422 module layout.

- (first RS485 line) JP1 in position 1-2 enables the transmission (TX) from the signal TXEN of microcontroller (1 = ON); in position 2-3 enables the TX; if open disables the TX.

- (second RS485 line) JP3 in position 1-2 enables the reception (RX) from the signal TXEN of the microcontroller (0 = ON); in position 2-3 enables the reception; if open disables the RX.

- (second RS485 line) JP1 in position 1-2 enables the transmission (TX) from the signal TXEN of microcontroller (1 = ON); in position 2-3 enables the TX; if open disables the TX.

Figure 3.25 shows the module layout with the location of the various jumpers.

JP3: 1-2 chiuso: ricezione On/Off dal segnale TXEN del uP (0 = ON); 2-3 chiuso: ricezione On OPEN: Ricezione Off JP1: 1-2 chiuso: trasmissione On/Off dal segnale TXEN del uP (1 = ON); 2-3 chiuso: trasmissione On OPEN: Trasmisione Off

JP6: 1-2 chiuso: ricezione On/Off dal segnale TXEN del uP (0 = ON); 2-3 chiuso: ricezione On OPEN: Ricezione Off JP4: 1-2 chiuso: trasmissione On/Off dal segnale TXEN del uP (1 = ON); 2-3 chiuso: trasmissione On OPEN: Trasmisione Off

Figure 3.23 shows the module layout with the location of the various jumpers.

RS485 module

This module can be used to export the UART pins linked to the UART peipherals on the dsPIC by using signals which are compatible with the RS485 standard (see Figure 3.24).

The module has three jumpers named JP1, JP2, and JP3 which can be used for the following purposes:

- JP1 controls the termination of the RS485 line;

- JP2 in position 1-2 enables the reception (RX) from the signal TXEN of the microcontroller (0 = ON); in position 2-3 enables the reception; if open disables the RX.
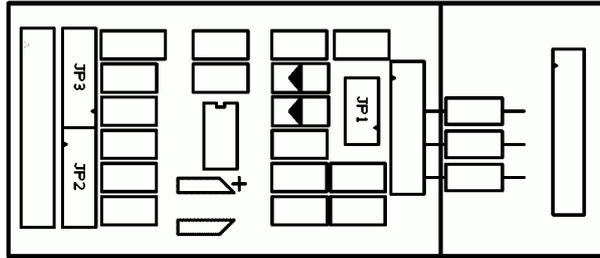
Figure 3.24: The UART RS485 module.

Figure 3.25: The UART RS485 module layout.

- JP3 in position 1-2 enables the transmission (TX) from the signal TXEN of microcontroller (1 = ON); in position 2-3 enables the TX; if open disables the TX.

Figure 3.25 shows the module layout with the location of the various jumpers.

I2C module

This module can be used to connect in a safe way an I2C bus to one of the I2C peripherals of the dsPIC. The protection includes protection from spikes, as well as hot inserction and hot extractions.

SPI module

The module can be used to export one of the SPI peripheral pins which are available on the dsPIC (see Figure 3.26). Moreover, the module has a set of components which are used to protect the microcontroller pins from input signals which are not compatible with the specifications.

The module has four jumpers named JP1, JP2, JP3 and JP4 which can be used to put in high impedance respectively the digital output, clock, digital input and chip select signals. Figure 3.27 shows the module layout with the location of the various jumpers.
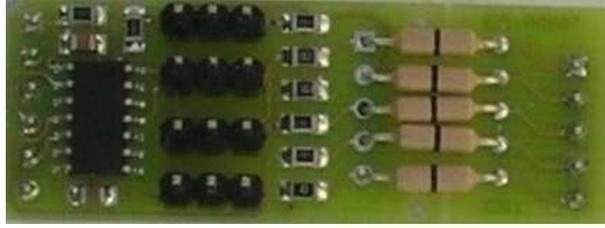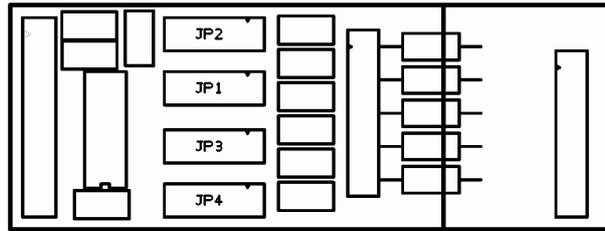
Figure 3.26: The SPI module.

Figure 3.27: The SPI module layout.

CAN module

The module can be used to export the CAN peripheral pins which are available on the dsPIC using a CAN transceiver (see Figure 3.28).

TPUART module

The module can be used to export the UART peripheral pins which are available on the dsPIC by using a bus compatible with the EIB / Konnex specifications.

Ethernet module

The module can be used to export an ethernet connection through the RJ45 connector available on the Multibus base board. The ethernet chip used is the Microchip ENC28J60, which is connected to the dsPIC by using the SPI bus (see Figure 3.29). Please note that this module is sold with the RJ45 connector which has to be solded to
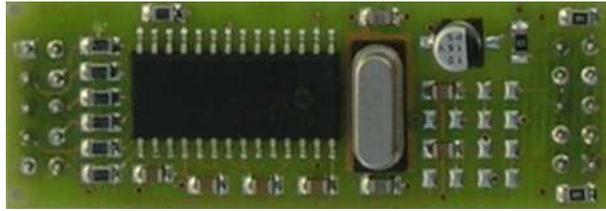

Figure 3.28: The CAN module.

Figure 3.29: The Ethernet module.

the Multibus base board. The multibus base board is typically sold without the RJ45 connector.

4 Hardware customizations

There are a number of possible extensions which can be made to the FLEX boards to add new functionalities, sensors, network connections, actuators, and so on. The simplest extensions can be made by hand by using a Thru Hole board.

Unfortunately, some nice extensions may require an expertise which may require special equipment (e.g., to mount SMD components) to implement a fully functional board.

To avoid this problem, Embedded Solutions Srl is available to cover specific customization needs which can bring you to the production of a custom daughter board for FLEX. Depending on the number of items to be produced, a re-engineering of the entire board which merges the base and the daughter board could be convenient to save on size, weight, and power consumption. Embedded Solutions also covers the prototyping of multilayer boards with SMT and PTH technologies.

If you are considering the design of a custom FLEX daughter board, please contact us!

5 Sofware development for the FLEX boards

The FLEX boards comes with a rich software infrastructure which symplifies the application development.

5.1 Erika Enterprise **and** Erika Enterprise Basic

First of all, FLEX comes with Erika Enterprise and Erika Enterprise Basic as the default software development environment. In particular, Erika Enterprise and Erika Enterprise Basic for the Microchip dsPIC (R) DSC micro-controller family is available as a complete development environment for real-time applications. It includes the state of the art real-time technology as well as the RT-Druid configuration tool, which allows easy design and optimization of a real-time application.

5.2 Libraries for FLEX

Erika Enterprise and Erika Enterprise Basic fully supports the FLEX boards and all the Daughter Boards. A complete set of libraries allows the exploitation of all the features provided. The development of complex applications based on the FLEX Base Board and available Daughter Boards is simplified by a well documented and clear set of primitives. The needed libraries can be configured using the RT-Druid tool, letting the developer to dedicate the efforts to the implementation of the program logic.

5.3 Template applications

A set of template applications using the FLEX boards are also available. These applications can be instantiated as RT-Druid projects by selecting the appropriate template at project creation time.

5.4 Scilab and Scicos code generator

Finally, a code generator for Scilab and Scicos designs is also available. The code generator has been developed in collaboration with Simone Mannori from INRIA (FR) [2], and Roberto Bucher from SUPSI Lugano [1]. Please check the Evidence web site http://www.evidence.eu.com to get updated documentation and manuals about the Scilab/Scicos code generator support.

6 How to buy

The FLEX board is available through the following selected distributors:

6.1 Italy

Link to the e-commerce web site:

- FLEXFull - http://www.elettroshop.it/dettagli.asp?pid=1352

- FLEXLight - http://www.elettroshop.it/dettagli.asp?pid=1355

Inware S.r.l.
Via Cadorna, 27/31
20032 Cormano (MI)
Tel: +39 02 66504794
Fax: +39 02 66508225
URL: http://www.inware.it/
Email: info[at]inware.it

6.2 United States of America

Link to the e-commerce web site:

- FLEXboards - http://microcontrollershop.com/default.php?cPath=112_160_316

Microcontroller Pros
Contact information: http://microcontrollershop.com/contact_us.php

Link to the e-commerce web site:

- FLEXboards - http://www.sparkfun.com/commerce/categories.php?cPath=2_133

Sparkfun Electronics
URL: http://www.sparkfun.com/

6.3 South America

Link to the e-commerce web site:

- FLEXboards - http://www.olimex.cl/index.php?cPath=76_79

Ingeniería MCI Ltda. (Olimex Chile) Electronics
URL: http://www.olimex.cl/

6.3.1 What if my country is not in the list?

Please select the nearest distributor to your site!

6.3.2 We are looking for distributors!

If you are a distributor and you want to distribute FLEX in selected countries, please do not hesitate to contact us!

7 History

Version	Comment
0.1	Initial revision.
0.2	Re-style of sections sequence and partition. Added new pictures and content. Added tables about leds and jumpers.
0.21	Corrected some typos. Started section about the Thru Hole board. Updated style to include the Embedded Solutions logo. Added description to jumpers of the Ligth board.
0.22	Splitted app-notes.tex from the main content file. Added new picture about the piggybacking architecture.
0.23	New pictures for the latest FLEX boards.
0.25	Updated pictures of Thru Hole board and comparison between Base boards.
0.26	Updated ES logos. Updated typos, and added How to buy section.
0.27	Typos.
0.28	Typos. Added multibus section, added USA distributors.
0.29	Added rear photos of Flex light and full. Added South America distributor.
0.30	Added mechanical description, added pinout mapping.

Bibliography

[1] Roberto Bucher. Roberto Bucher home page. http://web.dti.supsi.ch/~bucher/, 2005.

[2] Scilab Consortium. The Scicos home page. http://www.scicos.org, 2005.