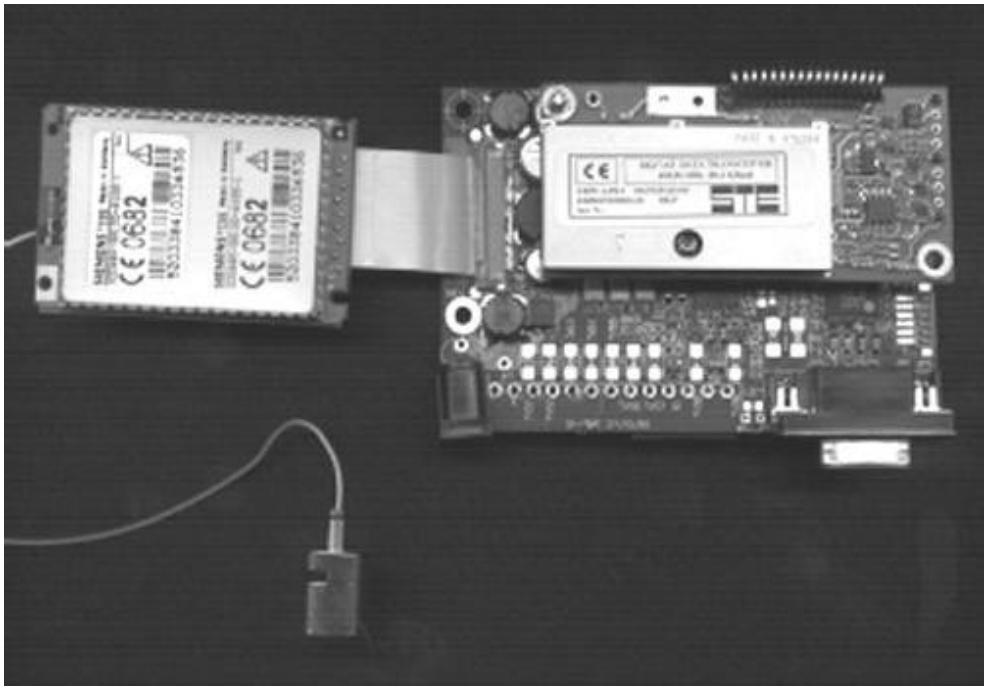
Sesamo3535

A Modular, ANSI C Programmable System
for GSM/Radio Control of Industrial Applications

Advance Information



List of Sections

Section 1. General Description

1.1 Introduction

Sesamo35 is a modular and ANSI C programmable system designed for remote control of industrial processes through a GSM network or a short-range radio link.
Sesamo35 is based on the high-performance ANSI C programmable Mitsubishi® 30620 microcontroller (M16C family); the system embodies up to 3 optocoupled digital inputs, up to 3 optocoupled digital/power outputs, up to 3 analog inputs, an RS485 port, an RS232 port, and a RTC calendar with back-up battery. Furthermore, two communication modules can be hosted: a GSM modem (Siemens TC35), a radio modem (STE BK17 or STE BK18). The system can also be expanded with a credit-card form-factor custom board in case one or more particular functions are required. To minimize RFI emissions the system is designed on a six-layer PCB complete with two internal ground planes. The system is CE marked

1.2 Features

Power Supply: 9 – 30 VDC with resettable 1A protection fuse
Low Power Design
Microcontroller: Mitsubishi® 30620 with 128 KB flash EEPROM and 10 + 128 KB RAM
Watchdog timer: on chip
Power-up timer: 300 ms delay
Primary Quartz Crystal: 16 MHz
Secondary Quartz Crystal: 32.768 kHz
RTC Clock Calendar
Microcontroller Programming: In-system
Non-volatile File System: EEPROM 8KB or/and EEPROM 128KB
Optocoupled Digital Inputs: up to 3 (two inputs can be configured to read external relay contacts)
Optocoupled Digital/Power Outputs: up to 3 (all outputs can be used to drive external relays)
Analog Inputs: 4-20 mA, Linear Transducer, PT100, and 0 – 10V
RS485 Port: 1 (half duplex operations)
RS232 Port: 1 (full duplex operations and DTR/DSR handshake signals)
GSM Modem: Siemens TC35
Radio Modem: either STE BK17 or STE BK18 LPD modules (www.stecom.com)
Industrial Version: Terminal-block Connectors (*)
Desktop Version: DC Plug

(*) The Italian word is “Morsetto”

1.3 Dimensions and Housing

Sesamo35's PCB measures 60 X 90 mm and is designed to be lodged in industry-standard boxes.

1.4 Applications

- Remote control of industrial processes
- Remote control of PLCs
- GSM-based LCD panels for signaling and or advertisements
- Home automation
- Industrial alarms with GSM link
- Low-cost radio networks in industrial environments
- GPS assisted fleet navigation

1.5 Expanding Sesamo35

Sesamo35 functionality can be expanded with a custom circui. An expansion circuit is needed whenever a particular function is not directly implemented on Sesamo35.
For orders larger than 500 pieces, FATTI srl offers free consulting service in designing the interface circuit.

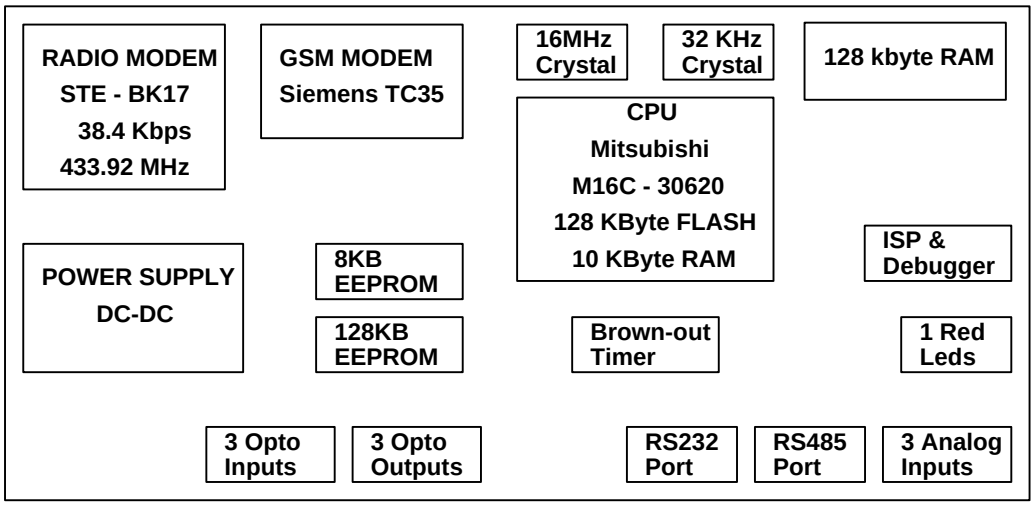
1.6 Functional Schematic Diagrams

In order to help customers develop software applications, FATTI srl provides functional schematics of Sesamo35. Functional schematics differ from the actual ones basically because no protection or RFI parts are shown. Functional schematics can not be redistributed on any medium without express written consent of FATTI srl.

Section 2. Block Diagram, CPU, EEPROM, and IO

2.1 Block Diagram

Sesamo35 is composed by many functional subsections that are controlled by the system's microcontroller. Shown below is a block diagram of the system:



2.2 CPU

System's CPU is the high-performance 16-bit Mitsubishi® M30620 microcontroller. This CPU offers a rich set of on-chip memory-mapped peripherals. Listed below are the main characteristics

CPU modes: Microcontroller and Microprocessor operations
Address Space: up to 1MByte
Program memory: Internal Flash EEPROM: 128 Kbytes or 256 Kbytes (on request)
Data Memory: Internal RAM: 10 Kbytes or 20 Kbytes (on request)
Data Memory: External RAM: 128 Kbytes (on request)
Main Clock: up to 16 MHz
Sub Clock: 32 kHz (low power activities)
Serial Synchronous Communication Modules: 5
Serial Asynchronous Communication Modules: 3 fully featured UARTs
Analog to Digital Converter Module: 8 or 10 bits resolution and 8 channels
Digital Inputs and Outputs: more than 80
Digital to Analog Converter Module: 2 channels
Keyboard interface Module: 1
DMA channels: 2
CRC hardware circuit: 1
Programming: in-system serial or parallel
Hardware Interrupts: more than 20
Software Interrupts: 32
RTOS support: available from many vendors

M30620 Flash program memory can be electrically erased and reprogrammed more than 1000 times. For further information, about Mitsubishi® M30620 microcontroller and programming tools, check out the website: www.m16C.com

2.3 Primary EEPROM

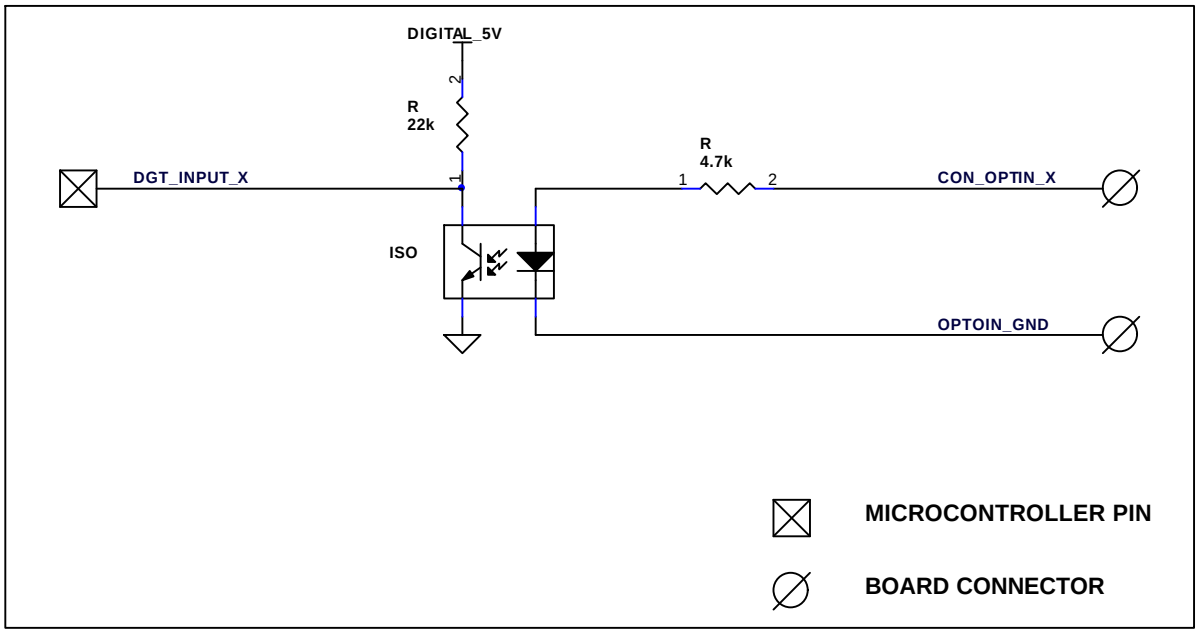
Sesamo35 makes use of Microchip® 25LC640 SPI EEPROM memory to store and read non volatile data such as configuration parameters, field data et cetera. This memory can store up to 8KBytes of data organized in a linear array of bytes at a data rate of 3 Mbit/s. One million of read/write cycles and 200 years of data retention are guaranteed by Microchip. Software APIs to read and write the memory are provided with the standard package. Refer to Microchip® 25LC640 (www.microchip.com) datasheets for the complete documentation and commands.

2.4 Secondary EEPROM

On request, it is possible to expand Sesamo35's non volatile memory with NexFlash® NX25F011B 128 Kbytes SPI EEPROM memory. Check for availability starting from June 2001.

2.5 Digital Inputs

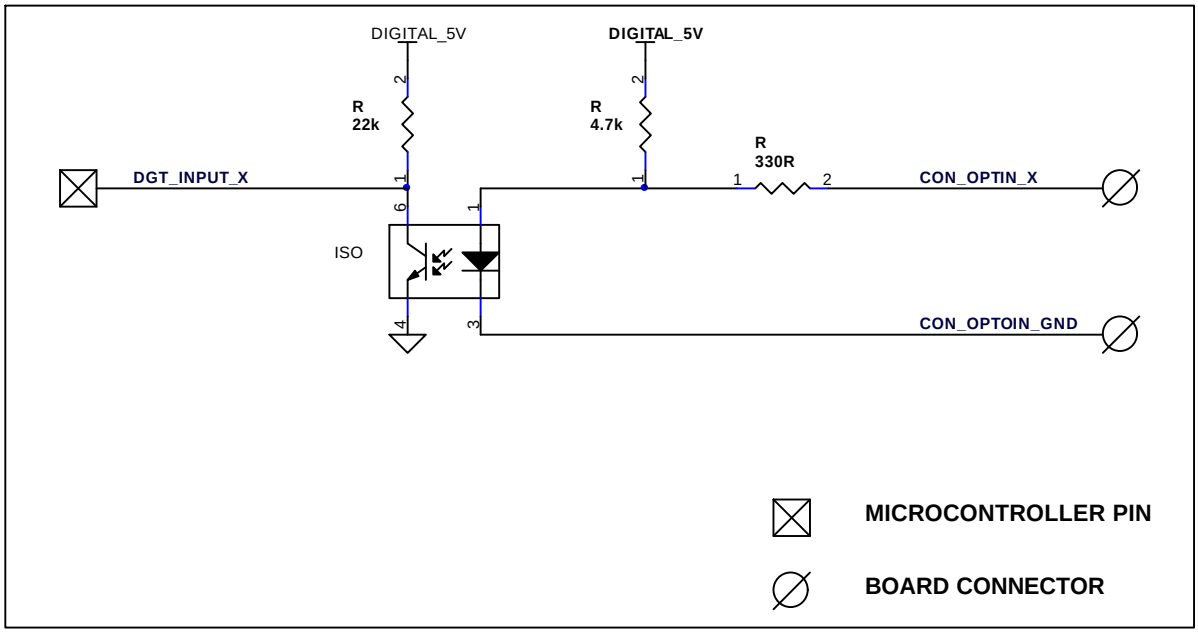
Digital Inputs can be used for on/off signaling between Sesamo35 and the host system. The current drawn by each input is very little: it ranges from a minimum of 1mA to a maximum 6 mA, depending on the voltage that drives the input resistance of 4.7 kÙ. As shown below, all digital inputs are optocoupled mainly to minimize system-to-system coupling and increase RFI immunity levels. Be aware of the fact that Sesamo35's internal ground plane is physically separated from Digital Input Ground which must be externally supplied, as shown below:



Optocoupled inputs allows for a great deal of flexibility when interfacing systems. In fact, Sesamo35 can be easily interfaced to 5 V as well as 24 V systems. Further, the grade of electromagnetic coupling between optocoupled systems is greatly reduced.
All digital inputs are protected from overvoltage and polarity reversal by fast clamp bi-directional diodes. The protection level is set to 30V, this means that all voltages greater than +30 V or smaller than -30V will be clamped. If, accidentally, input polarity is reversed (event not rare during installations) a current of at most 5 mA will flow from CON_OPTOIN_GND to CON_OPTOIN_X, where X is the input number.
Overvoltage protection is guaranteed between the signals CON_OPTOIN_X and OPTOIN_GND. FATTI srl strongly recommended, whenever the EARTH is present, to connect OPTOIN_GND to EARTH. No common mode filters are provided.

2.6 Relays Contacts Inputs

Upon request, and for volumes greater than 10 pieces, some or all optocoupled inputs can be hardware configured to read the contacts of external relays. In this case, electrical isolation between Sesamo35 and the host system is assured through the intrinsic isolation between the contacts and the bobbin of the external relays.
As shown below, whenever the signals CON_OPTOIN_X and CON_OPTOIN_GND are shorted together, the optotransistor turns off and the microcontroller will read 5 Volts.

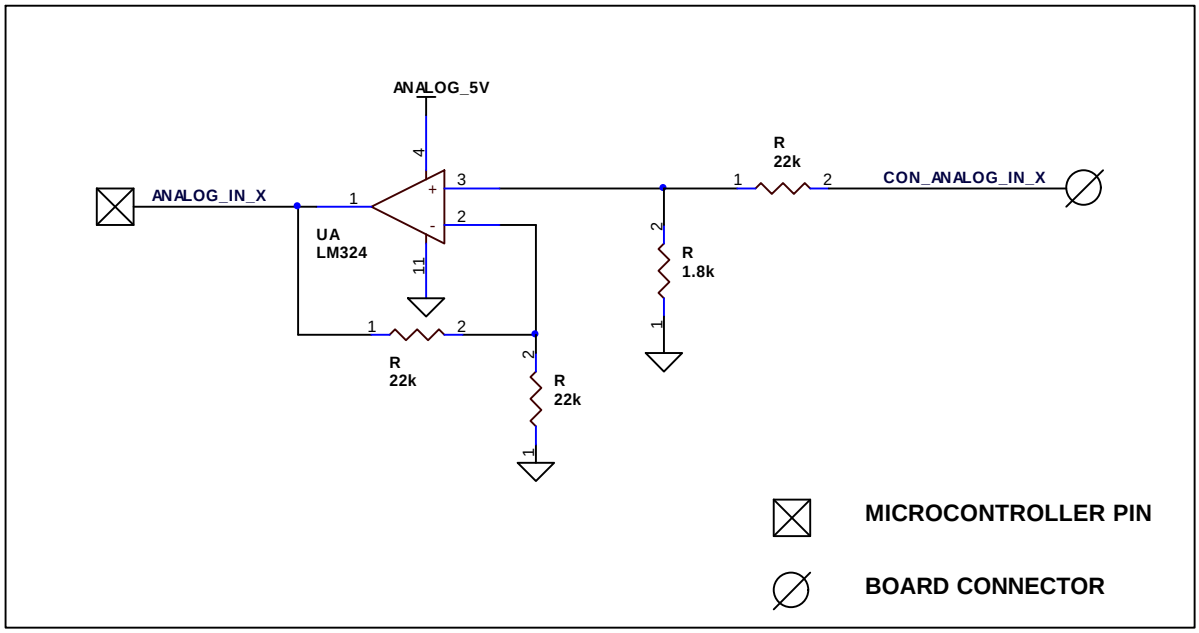


Since the signal CON_OPTOIN_GND is shared among all external contacts, pay attention when designing the interface between the host system and Sesamo35.

2.7 Analog Inputs

Sesamo35 can read three analog inputs: a 4-20 mA current loop signal, a PT100 or linear-resistor sensor, and a voltage signal in the range of 0-10 V. All analog inputs are protected from overvoltage and polarity reversal by fast clamp bi-directional diodes. The protection level is set to 30V, this means that all voltages greater than +30 V or smaller than -30V will be clamped. If, accidentally, input polarity is reversed (event

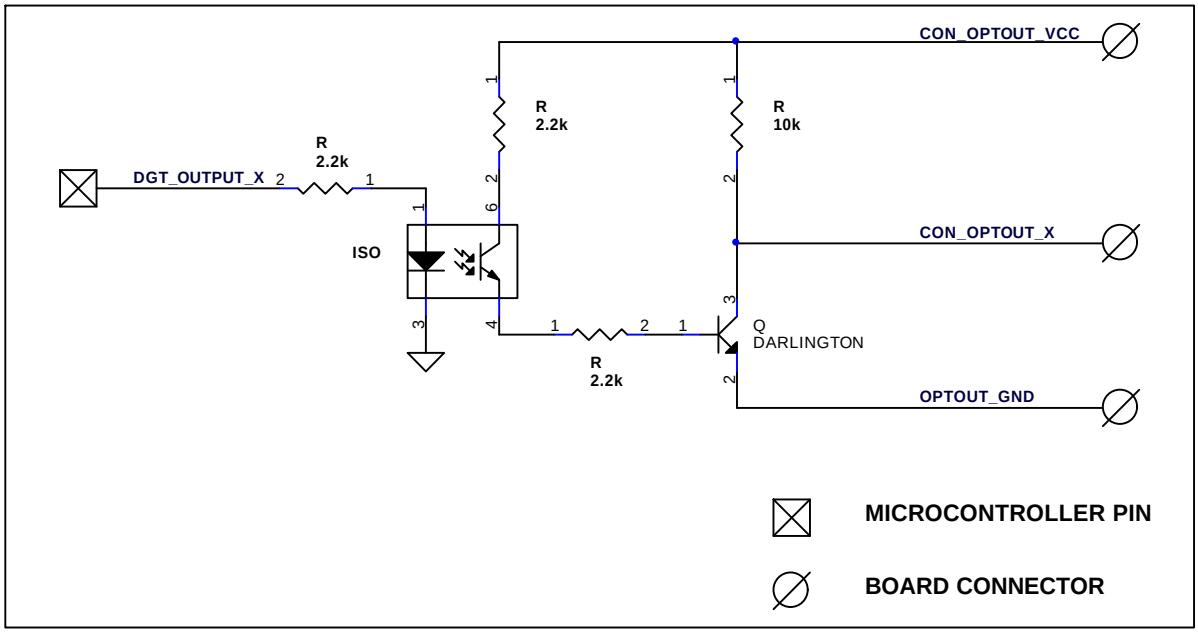
not rare during installations) a current of at most 1 mA will flow from CON_OPTOIN_GND to CON_OPTOIN_X, where X is the input number. No electrical isolation is provided between Sesamo35 and the host system. Software APIs are provided to read all analog inputs. Shown below, is the interface circui adopted to read signal analog voltages:



2.8 Outputs

Outputs can be used both to drive external relays or for on/off signaling. All outputs are optocoupled to minimize system-to-system coupling.

2.8.1 Digital Outputs



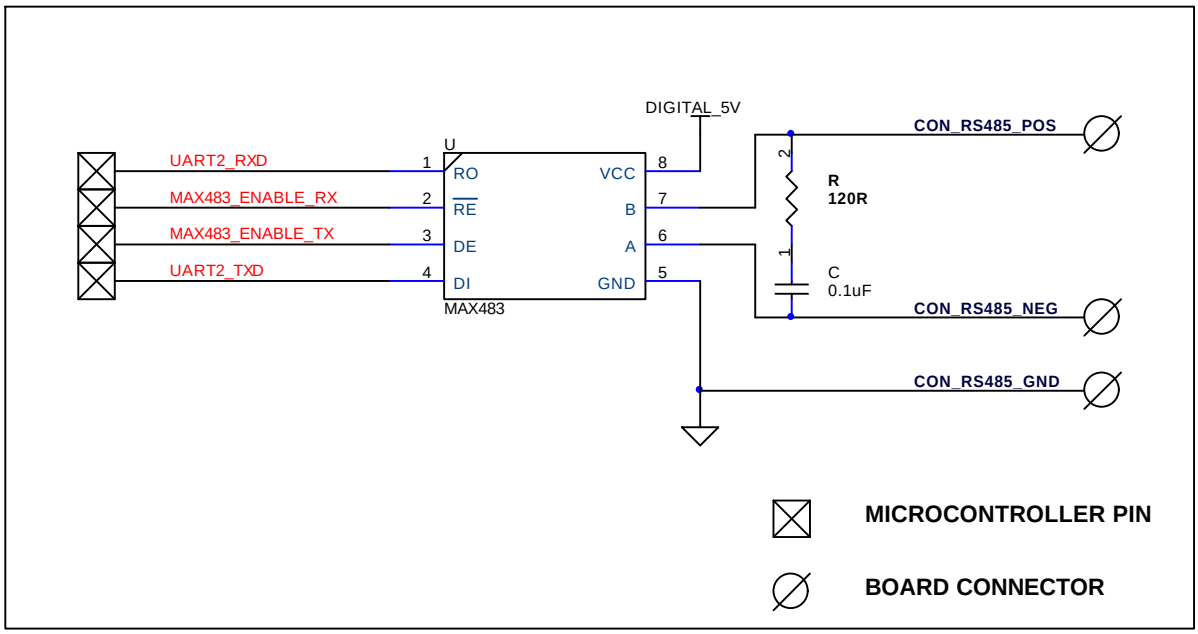
In order to use outputs, as general purpose ones, an external pull-up voltage is needed. The magnitude of the external pull-up signal ranges from a minimum of 5 Volts to a maximum of 30 Volts.
All outputs and the signal CON_OPTOUT_VCC are protected from overvoltage, with respect to OPTOUT_GND signal, by fast clamping diodes, whose threshold voltage is 30 Volts. Furthermore, all outputs and all the bipolar transistors are protected from voltage reversal by unidirectional diodes.
See the Electrical Characteristics tables for further information.

2.8.2 Power Outputs

All outputs can be used to drive external relays. An external pull-up voltage is still needed in order to drive the bobbins of the relays.

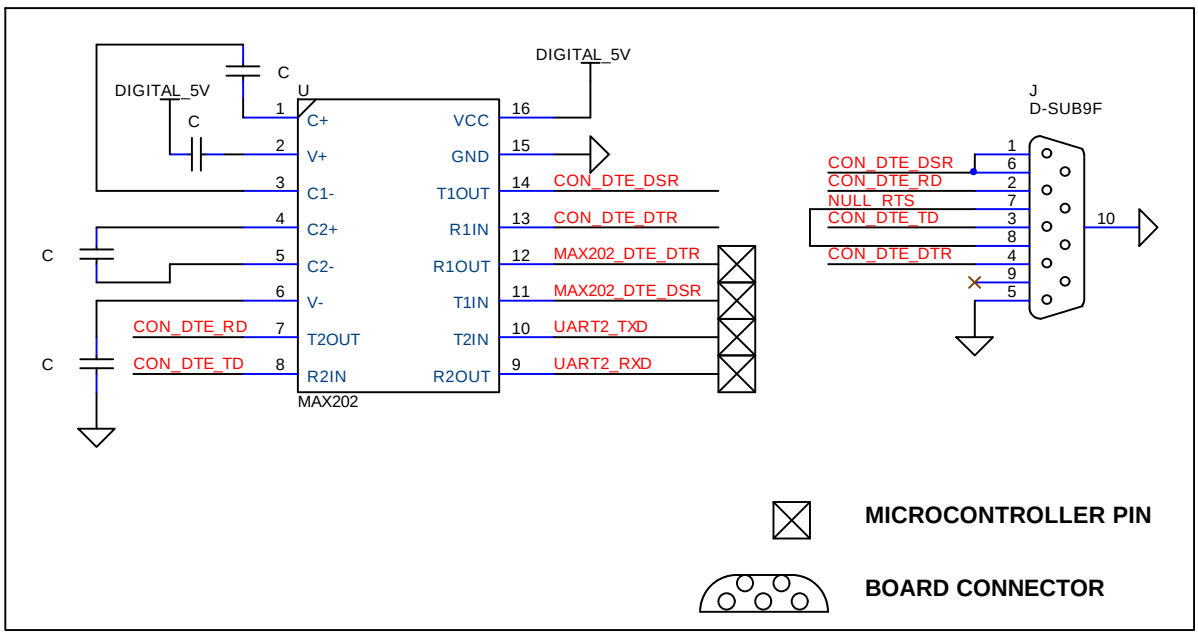
2.9 RS485 Port

Sesamo35 can access an RS485 bus through its RS485 half duplex port. RS485 buses, are inherently broadcast networks just like hub-based LANs. Whenever a host of this multi-drop network writes data to the bus, the others must listen. RS485 buses can span several meters therefore they must be terminated at the two farthest ends to preserve signal integrity and to prevent reflections. The characteristic impedance of this bus is usually around 120 . All hosts, but the farthest ones, that access the network must not present resistance termination. Sesamo35's RS485 port is terminated by a 120 Ù resistor in series with a 0.1 uF capacitor, therefore it must be used as one of the two end points of an RS485 network. For orders greater than 10 pieces, on request, the termination network can be removed. The capacitor is needed to save power during data transmission.
The functional diagrams shows that the RS485 chip is attached to serial interface UART2 of the microcontroller, therefore data are transmitted as single characters with one stop bit and one or two stop bits.
The maximum data rate achievable by the RS485 transceiver chip, whose output transistors drivers are slew rate limited, is 120kbs. The RS485 chip can be shut down during stand-by operations, in this state the signal RO, A, and B are tri-stated.
For further information about RS485 networks see Maxim's RS485 datasheet.



2.10 RS232 Port

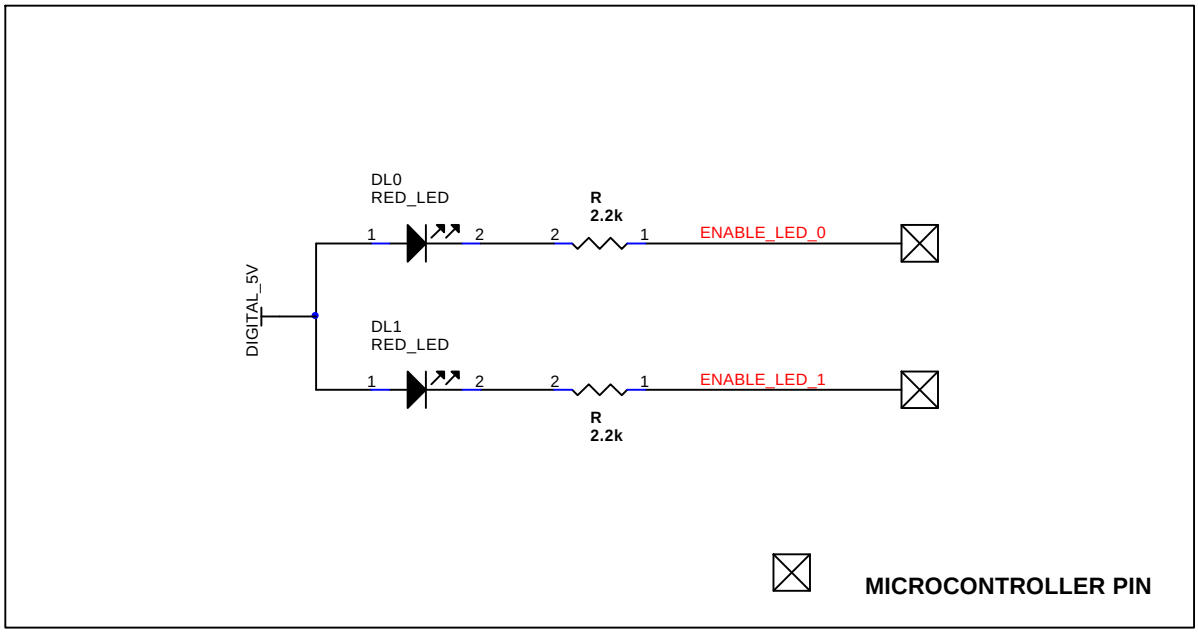
Sesamo35 can communicate with PCs, PLCs, an industrial machines through its RS232 full duplex port. Usually an RS232 port is used for parameters upload and download or for PC communications. In industrial environments it strongly suggested to use short cables for RS232 data transmission; this limitation arises from the fact that RS232 interfaces are single ended lines, therefore inherently susceptible to environment noise. Sesamo35's RS232 port provides also DTR and DSR handshake signals.



Section 3. General Purpose Leds

3.1 General Purpose Led

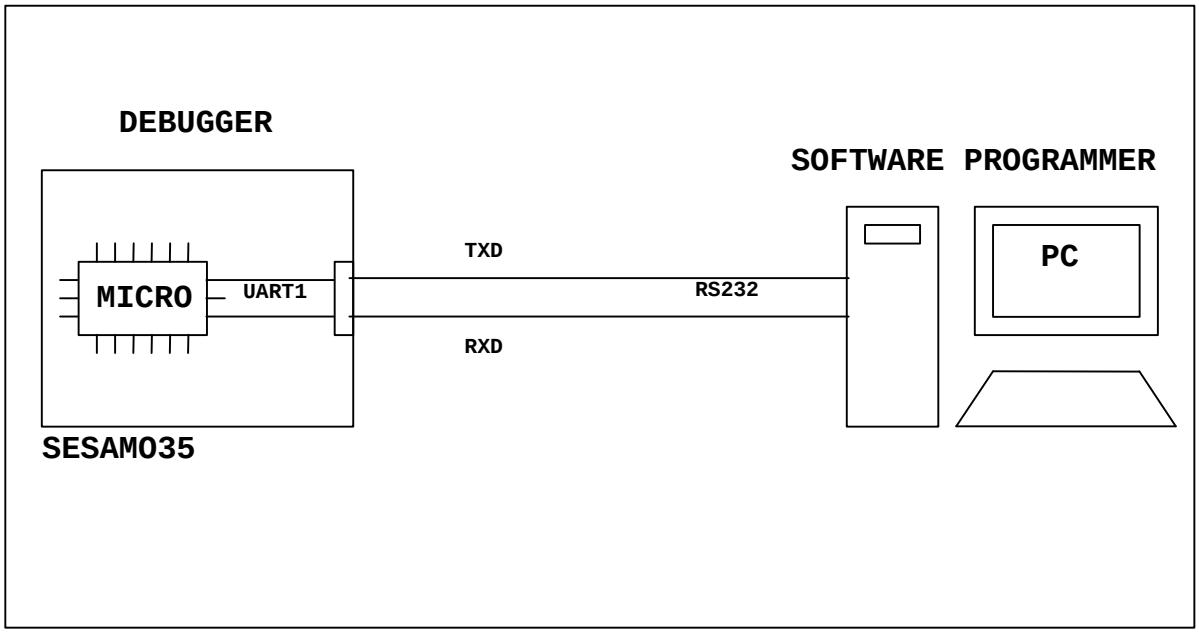
Sesamo35 has a two general purpose red leds that can be used to visually represents the state of meaningful signals such as carrier detects, modems ring signals, microcontroller operating properly and so on. Also, during the installation stage (hardware deployment and software configuration) leds signaling can help understand whether there are problems or not. Software APIs are supplied to control the led.



Section 4. In-System Programming and Debugging

4.1 In-system programming

Sesamo35's microcontroller is to be programmed through a software programmer that runs on a Personal Computer.



4.2 In-system Debugging

Sesamo35 comes with a software debugger that runs on the microcontroller while the user interface of the debugger runs on a PC. Up to one breakpoint at C source-level can be configured, also the embedded application can be executed step by step.

Section 5. Communications Modules

5.1 BK17 or BK18 Radio Modems

Sesamo35 can host the BK17 or BK18 radio modems, which are designed, produced and sold by STE (www.stecom.com). This module is compliant to both ETSI 300 and CE directives. These radio modules falls into the category of Short Range Devices also known as LPDs.
The BK17 radio modem works at the frequency of 433.92 MHz while the BK18 works at 868 MHz. Both the modems modulate data according to the on/off modulation: namely, logic ones are represented by the presence of power at the work frequency while logic zeros are represented by the absence of power at that frequency. See www.stecom.com for further information and for the datasheets.

5.1.1 Data Transmission Radio Protocols

The radio channel is always “dirty”, especially in industrial environments. Yet, the 433.92 MHz frequency can be used by others devices. To help software programmers design radio protocols, the BK17 presents an analog output signal (the MON signal, see BK17 datasheet) that carries the information about the RF power in the 433.92 MHz frequency. This signal is very important during the deployment phase of the application because it can give an idea about the environmental noise. This analog information is read by Sesame's analog-to-digital converter and made available through a software API.
Radio frames should start with one or two preamble bytes that carries many phase transitions (usually 0x55 is a good preamble byte). Phase transitions are used by the receiver to synchronize. Data are not required to carry signal transitions because the receiver circuitry is quite insensible to the mean value of the packets so, data encoding is not strictly necessary. In any case, use Manchester encoding for better data throughput.
Data to be transmitted over the radio channel must be fragmented into packets no longer than 64 bytes. Also, a16 bit cyclic redundancy checks (CRC) must be performed by the software driver that reads data coming from the radio channel. Note that the Mitsubishi® M30620 microcontroller can perform CRC calculations in hardware. See Internet RFC?? for C source code of a standard software reentrant CRC function.
Software APIs for the BK17 radio modem will be available by the end of June.
See BK17 datasheet for further information about protocols.

5.2 Siemens® TC35 GSM Modem

Sesamo35 can host the Siemens® TC35 GSM modem. These modems are meant for full duplex data transfer, SMS exchange, Fax and DTMF coding and encoding. As of March 2001, the maximum bit rate that the GSM network during data connections is 9600 or 14.400 bps depending on the carrier chosen. Both the modems implement ITU standard modulations and an AT software interface. Furthermore, every GSM modem implements a specific AT+ command set which allows the external DTE to interact with internal registers of the modem. Just like common mobile phones, these two modules can register to a GSM network only if a valid SIM card is inserted in the holder. Yet, not every SIM card is enabled for data transmission; indeed one must purchase data transmission enabled SIM cards only. Furthermore, all SIM cards expire after a certain period of inactivity (a year, usually) and after the expiration all credits are lost.

Section 6. Connectors Pin-Out

6.1 Connectors

Sesamo35 comes with Terminal Blocks. To be continued.

Section 7. C Compilers and Tool Chains

7.1 Tool chains

There are on the market many C compilers and tool chains suitable to program and debug the M30620 microcontroller. The following list names in alphabetical order some vendors: IAR® (www.iar.com), Mitsubishi® (www.mitsubishi.com), Tasking ® (www.tasking.com).
Mitsubishi® offers a tool chain composed by an ANSI C compiler, an assembler, a linker, a locator, a software debugger, a software emulator, and a programmer. These tools are granted for free for an evaluation period of 4 months from the date of the actual installation.

7.2 Real Time Operating Systems for M16C family

Complex embedded applications may need the support of a real time operating system or RTOS for short. An RTOS allow an application to be partitioned into independent tasks, optimize CPU time and have Interrupt Service Routines short.
There are several Real Time Operating Systems for the M16C family: MR30 (by Mitsubishi®), CMX® (by CMX), embOS® (by Segger)
A noticeable RTOS that comes complete with source code, good explanations and examples is Jean J. Labrosse's uC/OS II, which has been ported to many microcontrollers, included Mitusbishi M16C. Basically, the deal is the following: "purchase the book and get the source code for free". However, there is a small fee to pay whenever uC/OS II is embedded in a commercial application. For further information, visit Labrosse's site: www.micrium.com

7.3 Useful Links

www.infomicom.mesc.co.jp (Mitsubishi® developers and designers reference site)
www.segger.com (Debug tools, emulators, RTOS)
www. micrium.com (RTOS)
www.cmx.com (Internet remote control tool and RTOS)
www.emware.com(Internet reemit control tool)

Section 8. System Grounding, Earth, and Interfacing

To be defined.

Section 9. Software APIs and Sesamo35 Framework

9.1Software APIs

Sesamo35 comes with a certain number of software APIs that mask external devices like EEPROM memories, RS232 and RS485 ports and IO ports to programmers. APIs are C reentrant functions that may be called from within a program. A programmer may use FATTI srl APIs or develop ones of her own.

9.2 Sesamo35 Framework

A software framework is something that goes beyond APIs: it is a set of cooperating functions that make up a reusable design for a specific application. In words, a framework predefines some fundamentals design functions so that a programmer can concentrate on the specifics of the application: the programmer customize the framework by adding application-specific functions.
To be continued.

Section 10. CE conformity

10.1 CE tests

Sesamo35 complies with the following European Directives: EN 50081-1 and EN 50082-1

Radiated emissions (30, 1000) MHz
Radiated immunity to amplitude modulated electric fields (80, 1000) MHz @ 10 V/m
Radiated immunity to pulse modulated electric fields (900 +/- 5) MHz @ 10 V/m
Radiated immunity to 50 Hz magnetic fields 30 A/m
Conducted immunity to 80% AM, 1KHz electric field (0.15,80) MHz applied to I/O, DC, and PE
Fast transients immunity applied to I/O, DC, and PE @+/- 1KV

Conducted and emission tests were executed at EMIT's laboratories (www.emit.polimi.it)

Section 11. Technical Support

To be defined.

Section 12. Warranty and Serial Numbering

To be defined.

Section 13. Electrical Specifications

13.1 Absolute Maximum Ratings

Maximum ratings are the extreme limits to which the system can be exposed without permanently damaging it. This system is not guaranteed to operate properly at the maximum ratings. Refer to the Functional Operating Ratings for guaranteed operating conditions.

Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Power Supply	Vin	-30	+30	V
Digital Inputs	Din	-30	+30	V
Digital/Power Outputs	Dout	-30	+30	V
Analog Inputs	Ain	-30	+30	V
Relay contacts	Rcon			
RS485 Bus	RS485	-6.5	+6.5	V
Back-up Battery Input	Vbatt	+30	-10	V
Storage temperature	Tstg	-	-	C

13.2 Functional Operating Ratings at 12V Supply

Electrical Characteristics @12 Volt Supply, @12V Pull-up and 25 C free-air temperature

Parameter	Symbol	Min	Typical	Max	Unit
Supply Input Current @ 16MHz	Is				mA
Supply Input Current @ 32.768 kHz	Isl				mA
A/D chain conversion error	ADERR			3%	
Analog Input Current @ AIN =24 V	IAIN			1	mA
Analog Inputs Capacitance	CAIN			100	nF
Analog Inputs signal bandwidth	ABW			5	kHz
Low-level Digital/Power Output	VOL			1.3	V
High-Level Digital/Power Output	VOH	12			V
Pull-up Output Resistance	ROUT		10		KOhm
Input Current Per Channel	IIN			100	mA
Digital/Power Output current	IOUT			1.2	mA
Low-level Digital Input voltage	VIL			0.6	V
High-Level Digital Input voltage	VIH	4.7			V
Digital Output capacitance	COUT			10	pF
Digital Input capacitance	CIN			100	nF
Digital Input Current @ VIL = 5 V	IIN			0.8	mA
Digital Input Current @ VIL = 12 V	IIN			2.3	mA
Digital Input Current @ VIL = 24 V	IIN			4.9	mA
Digital Input Voltage Fall Time	Tr			3	uS
Digital Input Voltage Rise Time	Tr			3	uS
RS485 bit rate	Br485			120	Kbps
RS485 termination resistance	Rterm			120	Ohm
RS485 static current consumption	I485ST	0			mA
RS232 bit rate	Br232	0		120	Kbps

15.3 Functional Operating Ratings at 24V Supply

Electrical Characteristics @24 Volt Supply, @24V Pull-up and 25 C free-air temperature

Parameter	Symbol	Min	Typical	Max	Unit
Supply Input Current @ 16MHz	Is				mA
Supply Input Current @ 32.768 kHz	Isl				mA
A/D chain conversion error	ADERR			3%	
Analog Input Current @ AIN =24 V	IAIN			1	mA
Analog Inputs Capacitance	CAIN			100	nF
Analog Inputs signal bandwidth	ABW			5	kHz
Low-level Digital/Power Output	VOL			1.3	V
High-Level Digital/Power Output	VOH	12			V
Pull-up Output Resistance	ROUT		10		KOhm
Input Current Per Channel	IIN			100	mA
Digital/Power Output current	IOUT			1.2	mA
Low-level Digital Input voltage	VIL			0.6	V
High-Level Digital Input voltage	VIH	4.7			V
Digital Output capacitance	COUT			10	pF
Digital Input capacitance	CIN			100	nF
Digital Input Current @ VIL = 5 V	IIN			0.8	mA
Digital Input Current @ VIL = 12 V	IIN			2.3	mA
Digital Input Current @ VIL = 24 V	IIN			4.9	mA
Digital Input Voltage Fall Time	Tr			3	uS
Digital Input Voltage Rise Time	Tr			3	uS
RS485 bit rate	Br485			120	Kbps
RS485 termination resistance	Rterm			120	Ohm
RS485 static current consumption	I485ST	0			mA
RS232 bit rate	Br232	0		120	Kbps