National Semiconductor

LMX9820 Bluetooth™ Serial Port Module

LMX9820
Bluetooth™ Serial Port Module

General Description

The National Semiconductor® LMX9820 Bluetooth™ Serial Port module is a highly integrated radio, baseband controller, and memory device implemented on an LTCC (Low Temperature Co-fired Ceramic) substrate. All hardware and firmware is included to provide a complete solution from antenna through the complete lower and upper layers of the Bluetooth stack, up to the application including the Generic Access Profile (GAP), the Service Discovery Application Profile (SDAP), and the Serial Port Profile (SPP). The module includes a configurable service database to fulfil service requests for additional profiles on the host. The LMX9820 features a small form factor (10.1 x 14.0 x 1.9 mm) design; thus, solving many of the challenges associated with system integration. Moreover, the LMX9820 is pre-qualified as a Bluetooth Integrated Component. Conformance testing through the Bluetooth qualification program enables a short time to market after system integration by insuring a high probability of compliance and interoperability.

Based on National's CompactRISC™ 16-bit processor architecture and Digital Smart Radio technology, the LMX9820 is optimized to handle the data and link management processing requirements of a Bluetooth node.

The firmware supplied within this device offers a complete Bluetooth (v1.1) stack, including profiles and command interface. This firmware features point-to-point and point-to-multipoint link management supporting data rates up to 723 kbps. The internal memory supports up to three active Bluetooth links.

Applications

- Personal Digital Assistants
- POS Terminals
- Data Logging Systems
- Any serial data transmission

Functional Block Diagram
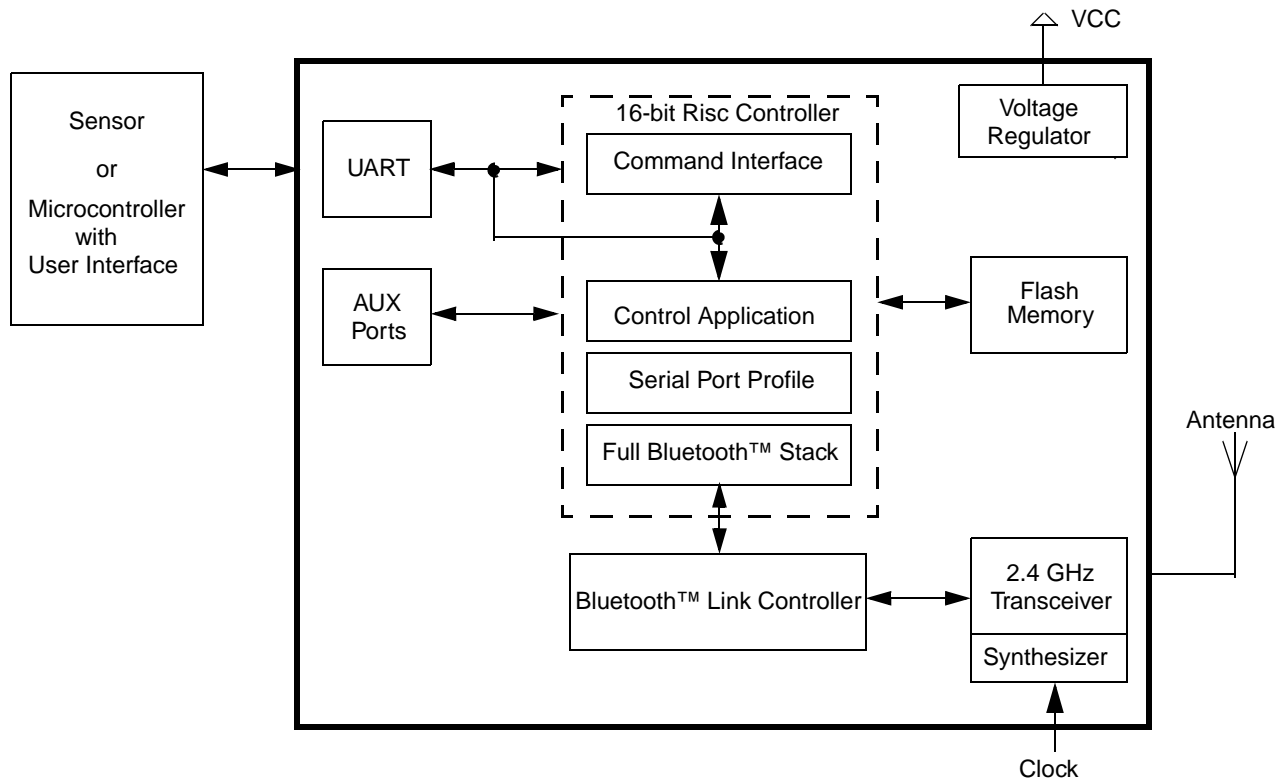
LMX9820 Bluetooth™ Serial Port Module

Features

DIGITAL HARDWARE

- Baseband and Link Management processors

- CompactRISC Core

- Integrated Memory:
  — Non-volatile data memory
  — Flash program memory
  — RAM

- UART Command/Data Port:
  — Support for up to 921.6k baud rate

- Auxiliary Host Interface Ports:
  — Link Status
  — Transceiver Status (Tx or Rx)
  — Operating Environment Control:
    – Run mode
    – In System Programming (ISP) mode

- Advanced Power Management (APM) features

FIRMWARE

- Complete Bluetooth Stack including:
  — Baseband and Link Manager
  — L2CAP, RFCOMM, SDP
  — Profiles:
    – GAP
    – SDAP
    – SPP

- Additional Profile support on Host for:
    – Dial Up Networking (DUN)
    – Facsimile Profile (FAX)
    – File Transfer Protocol (FTP)
    – Object Push Profile (OPP)
    – Synchronization Profile (SYNC)

- On-chip application including:
  — Command Interface:
    – Link setup and configuration (also Multipoint)
    – Configuration of the module
    – In system programming
    – Service database modifications
    – Default connections

  — UART Transparent mode

  — Different Operation modes:
    – Automatic mode
    – Command mode

DIGITAL SMART RADIO

- Accepts external clock or crystal input:
  — 12 MHz
  — 20 ppm cumulative clock error required for Bluetooth

- Synthesizer:
  — Integrated VCO and loop filter
  — Provides all clocking for radio and baseband functions

- Antenna Port (50Ω nominal impedance):
  — Embedded front-end filter for enhanced out of band performance

- Integrated transmit/receive switch (full duplex operation via antenna port)

- Embedded Balun

- Better than -77 dBm input sensitivity

- 0 dBm typical output power

PHYSICAL

- 10.1 x 14.0 x 1.9 mm

- Complete system interface provided in Land Grid Array on underside for surface mount assembly
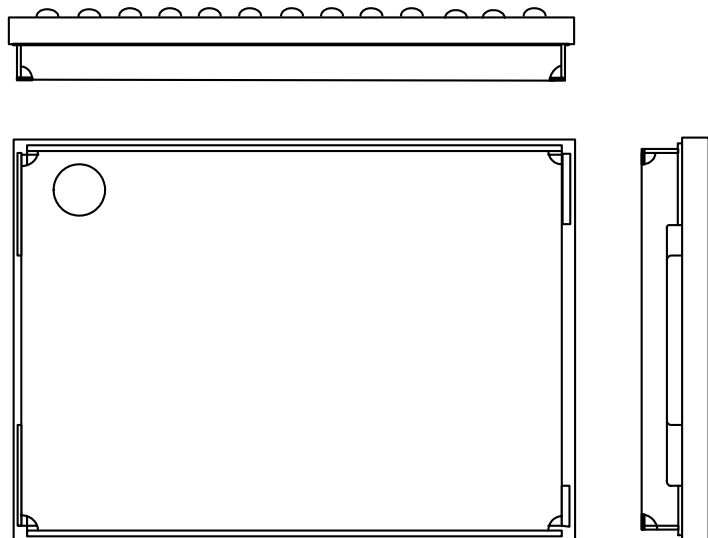
- Metal shield included

Figure 1. Physical Illustration

LMX9820 Bluetooth™ Serial Port Module

Electrical Specifications

GENERAL SPECIFICATIONS

Absolute Maximum Ratings (see Table 1) indicate limits beyond which damage to the device may occur. Operating Ratings (see Table 2) indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits.

This device is a high performance RF integrated circuit and is ESD sensitive. Handling and assembly of this device should be performed at ESD free workstations.

The following conditions are true unless otherwise stated in the tables below:

- T_A = -40°C to +85°C

- VCC = 3.0V

Table 1. Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VCC	Power Supply Voltage	-0.2	4.0	V
V_I	Voltage on any pad with GND = 0V	-0.5	VCC + 0.5	V
	RF Input Power		+15	dBm
T_S	Storage Temperature Range	-65	+150	°C
T_L	Lead Temperature (solder 4 sec.)		+260	°C
	ESD - Human Body Model		2000	V

Table 2. Recommended Operating Conditions[1]

Symbol	Parameter	Min	Typ	Max	Unit
VCC	Module Power Supply Voltage	2.85	3.3	3.6	V
IOVCC	I/O Power Supply Voltage	2.85	3.3	3.6	V
t_R	Module Power Supply Rise Time			50	ms
T_O	Operating Temperature Range	-40		+85	°C
	Humidity (operating, across operating temperature range)	10		90	%
	Humidity (non-operating, 38.7°C web bulb temperature)	5		95	%

1.   Maximum voltage difference allowed between VCC and IOVCC is 500 mV.

Table 3. Power Supply Requirements

Symbol	Parameter	Min	Typ	Max	Unit
I_{RXSI}-115	Receive Power Supply Current, Role Slave, transparent UART speed 115.2 kbps		41		mA
I_{TXSI}-115	Transmit Power Supply Current, Role Slave, transparent UART speed 115.2 kbps		43		mA

Functional Description

BASEBAND AND LINK MANAGEMENT PROCESSORS

Baseband and Lower Link control functions are implemented using a combination of National Semiconductor's CompactRISC 16-bit processor and the Bluetooth Lower Link Controller. These processors operate from integrated Flash memory and RAM. They execute on-board firmware implementing all Bluetooth functions.

Bluetooth Lower Link Controller

The integrated Bluetooth Lower Link Controller (LLC) complies with the Bluetooth Specification version 1.1 and implements the following functions:

- Support for 1, 3, and 5 slot packet types

- 79 Channel hop frequency generation circuitry

- Fast frequency hopping at 1600 hops per second

- Power management control

- Access code correlation and slot timing recovery

BLUETOOTH UPPER LAYER STACK

The integrated upper layer stack is prequalified and includes the following protocol layers:

- L2CAP

- RFComm

- SDP

PROFILE SUPPORT

The on-chip application of the LMX9820 allows full stand-alone operation, without any Bluetooth protocol layer necessary outside the module. It supports the Generic Access Profile (GAP), the Service Discovery Application Profile (SDAP), and the Serial Port Profile (SPP).

The on-chip profiles can be used as an interface to additional profiles executed on the host.

APPLICATION WITH COMMAND INTERFACE

The module supports automatic slave operation, eliminating the need for an external control unit. The implemented transparent option enables the chip to handle incoming data raw, without the need for packaging in a special format. The device uses a fixed pin to block unallowed connections.

Acting as master, the application offers a simple to use command interface for standard Bluetooth operation like inquiry, service discovery, or serial port connection. The firmware supports up to three slaves in operating mode and a master/slave switch for scatternet functionality.

CONTROL AND TRANSPORT PORT

The LMX9820 provides one Universal Asynchronous Receiver Transmitter (UART). It supports 8-bit, with or without parity and one or two stop bits. The UART can operate at standard baud rates of 9.6k, 19.2k, 38.4k, 115.2k, and multiples of 115.2k baud up to a maximum baud rate of 921.6k. It implements flow control logic (RTS, CTS) to provide hardware handshaking capability.

DUAL ON-CHIP VOLTAGE REGULATORS

The LMX9820 has dual internal voltage regulators capable of driving both the radio and baseband controller. This simplifies the design and reduces cost.

DIGITAL SMART RADIO

The LMX9820 Digital Smart Radio is a high performance, monolithic, radio transceiver optimized for Bluetooth communications systems.

The radio is a highly integrated design and includes the Low Noise Amplifier (LNA), mixer, on-chip filters, 2.5 GHz $\Delta\Sigma$ PLL, voltage controlled oscillator, Power Amplifier (PA) driver, and modem functions. Digital modulation and demodulation techniques are utilized for a robust manufacturable design. Power management includes control over individual chip functions and internal voltage regulation for optimum performance.

INTEGRATED FIRMWARE

The LMX9820 includes the full Bluetooth stack up to RFComm to support the following profiles:

- GAP (Generic Access Profile)

- SDAP (Service Discovery Application Profile)

- SPP (Serial Port Profile)

Figure 2 shows the Bluetooth protocol stack with command interpreter interface. Execution and interface timing are handled by the control application.
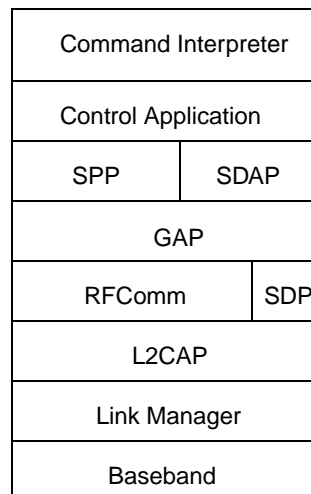

Figure 2. Bluetooth Protocol Stack

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OPERATION MODES

On boot-up, the application configures the module following the parameters in the data area.

Transparent Mode

The LMX9820 supports transparent mode on the UART interface. In normal operation, the packages must be formatted in a specific package format.

If activated, the module does not interpret the commands on the UART. It passes all data through the firmware to the active Bluetooth link.

Transparent mode can only be supported on a point-to-point connection.

Automatic Mode

No Default Connections Stored - In Automatic mode, the module is connectable and discoverable and automatically answers to service requests. The command interpreter listens to commands and links can be set up. The full command list is supported.

If connected by another device, the module sends an event back to the host, where the RFComm port has been connected, and switches to transparent mode.

Default Connections Stored - If default connections were stored on a previous session, once the LMX9820 is reset, it will attempt to connect each device stored within the data Flash three times. The host is notified about the success or non-success of the link setup via a link status event.

Command Mode

In Command mode, the LMX9820 does not check the default connections section within the Data Flash.

COMMAND INTERFACE

The LMX9820 offers an easy interface to configure the module and act as a Bluetooth node. The commands are sent within a specific hex format and are protected by a CRC code.

The interface offers commands for the following sections:

- Device Discovery
  — e.g. Inquiry

- Service Requests
  — e.g. SDAP Browse for services

- SPP Link Establishment
  — e.g. SPP establish link

- Local Bluetooth Configuration
  — e.g. Store Local Name
  — e.g. Set Security Level

- Bluetooth Low Power Modes
  — e.g. Enable Sniff Mode

- Local Hardware commands
  — e.g. Set UART baud rate

Typical Usage Scenarios

Scenario 1: Point-to-Point Connection
The LMX9820 acts only as a slave, no further configuration is required.

Example: A hand-held device (see Figure 3) with the standard Bluetooth option connecting to Sensor device, enabled by LMX9820.

The SPP conformance of the LMX9820 allows any device using the SPP to connect to the LMX9820.

Because of switching to Transparent automatically, the controller has no need for an additional protocol layer; data is sent raw to the other Bluetooth device.

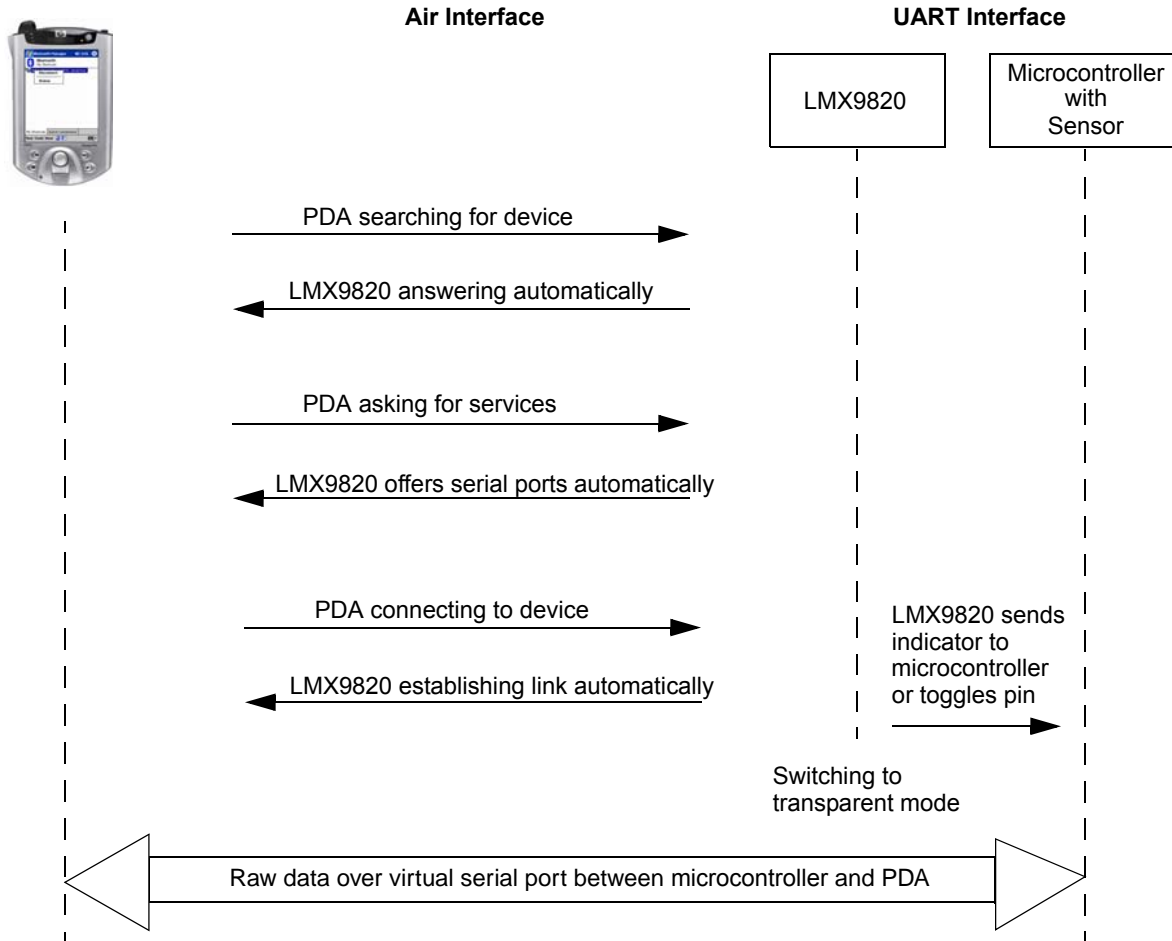On default, a PinCode is requested to block unallowed targeting.

Air Interface

UART Interface

LMX9820

Microcontroller with Sensor

PDA searching for device

LMX9820 answering automatically

PDA asking for services

LMX9820 offers serial ports automatically

PDA connecting to device

LMX9820 sends indicator to microcontroller or toggles pin

LMX9820 establishing link automatically

Switching to transparent mode

Raw data over virtual serial port between microcontroller and PDA

Figure 3. Point-to-Point Connection

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Scenario 2: LMX9820 Point-to-Point Connection
The LMX9820 automatically establishes the link to another device.

Example: Sensor connects to its host (in this case, the PDA) as soon it is swiched on. (See Figure 4.)
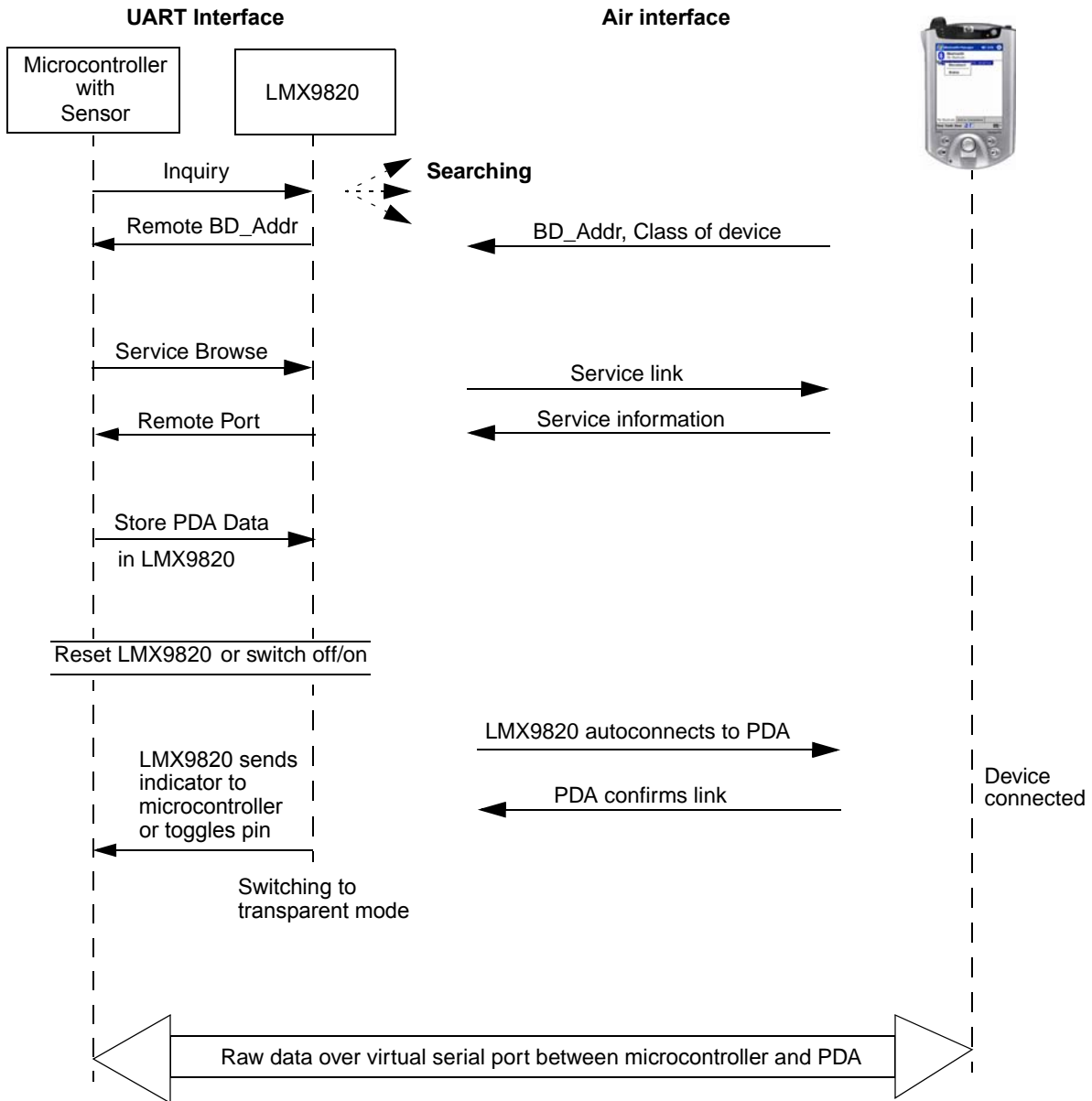
UART Interface

Air interface

Microcontroller with Sensor

LMX9820

Inquiry → **Searching**

← Remote BD_Addr

← BD_Addr, Class of device

Service Browse →

Service link →

← Remote Port

← Service information

Store PDA Data in LMX9820 →

Reset LMX9820 or switch off/on

LMX9820 sends indicator to microcontroller or toggles pin

LMX9820 autoconnects to PDA →

← PDA confirms link

Device connected

Switching to transparent mode

Raw data over virtual serial port between microcontroller and PDA

Figure 4. Automatic Point-to-Point Connection

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