LMX3162: Enabling 2.4GHz Applications

February 23, 1999

Agenda

- **The news: LMX3162**
- **National and wireless**
- **The 2.4GHz opportunity**
  - **Data, WLAN and the emerging home networking market**
  - **Traditional “cordless” applications**
- **LMX3162 2.4GHz transceiver**
- **Product roadmap**
- **Summary**

Wireless Communications

The News: LMX3162

National Semiconductor delivers industry's first single-chip radio transceiver for emerging 2.4GHz wireless applications

Applications

- **2.4 GHz voice/cordless**
- **Multiple consumer and commercial wireless LAN and data protocols**
- **Proprietary wireless protocols**

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National and Wireless

- **National's analog product can be found in many of the leading handset models today**
  - **Low Drop-Out voltage regulators (LDOs)**
  - **Op-Amps**
  - **Phase Locked Loops (PLLs)**
- **Since market entry in the early 1990s, National has become the leader in radio frequency (RF) PLL ICs**
  - **Shipped > 150M PLLatinum™ Phase Locked Loops to date**
  - **National is referred to as "defacto standard" --Dataquest**
  - **"National's new devices have raised the performance bar in the PLL business" –*EBN***
- **National is the leading supplier of cordless DECT chipsets**
  - **RF and baseband solutions**
  - **Released 5th generation product**

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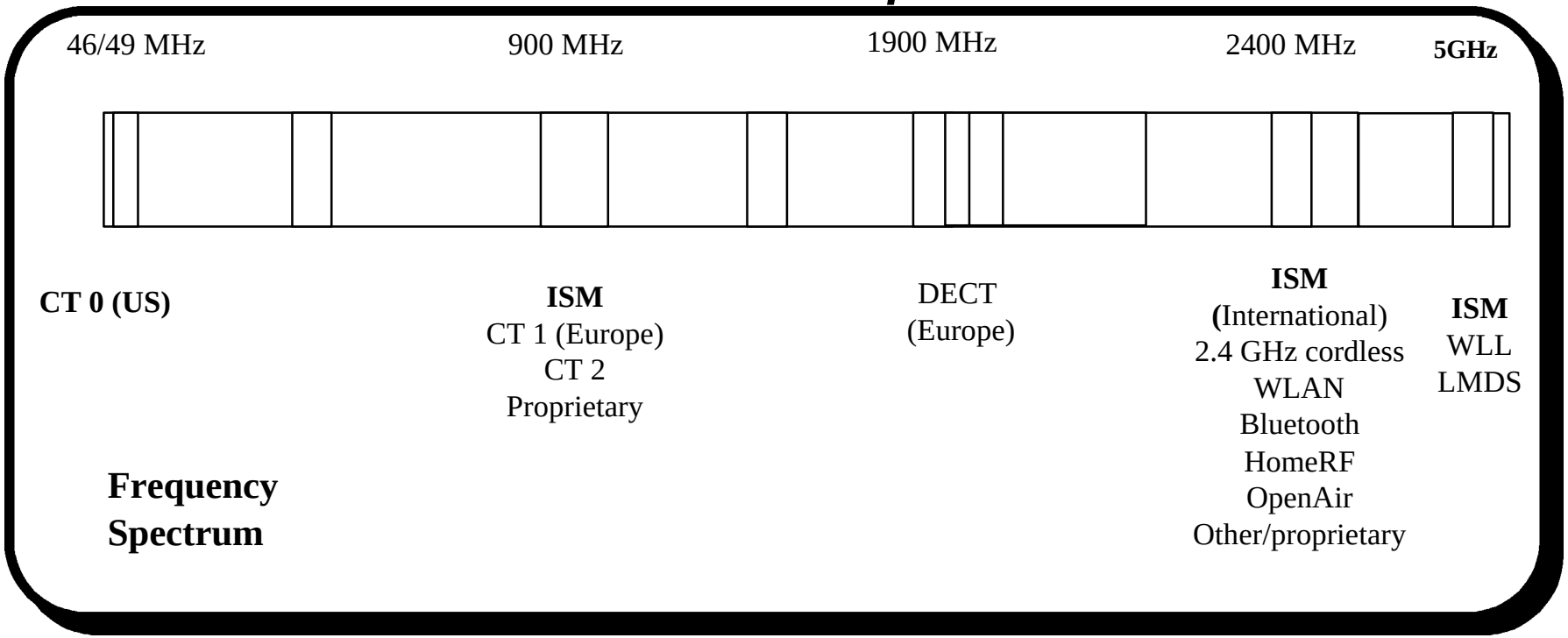
National Semiconductor has a history of wireless innovation

"Cordless" Spectrum



How has this changed with time?

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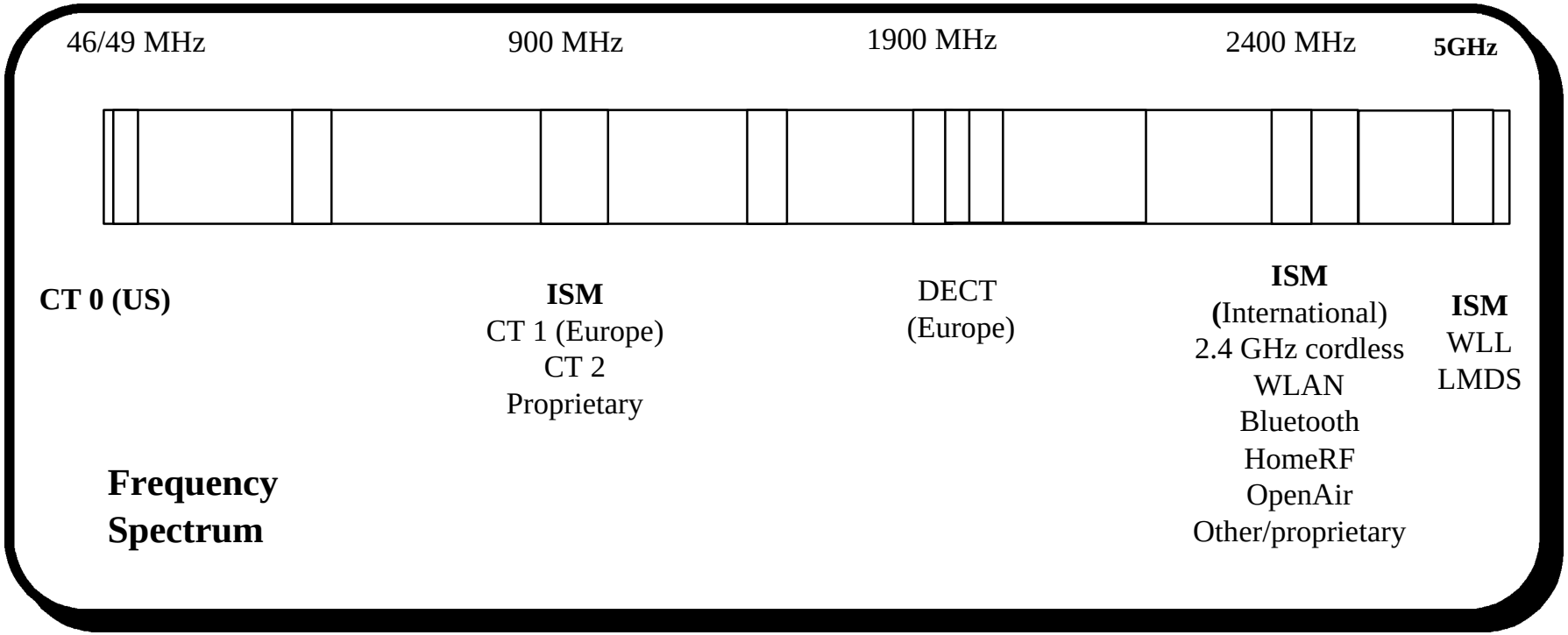
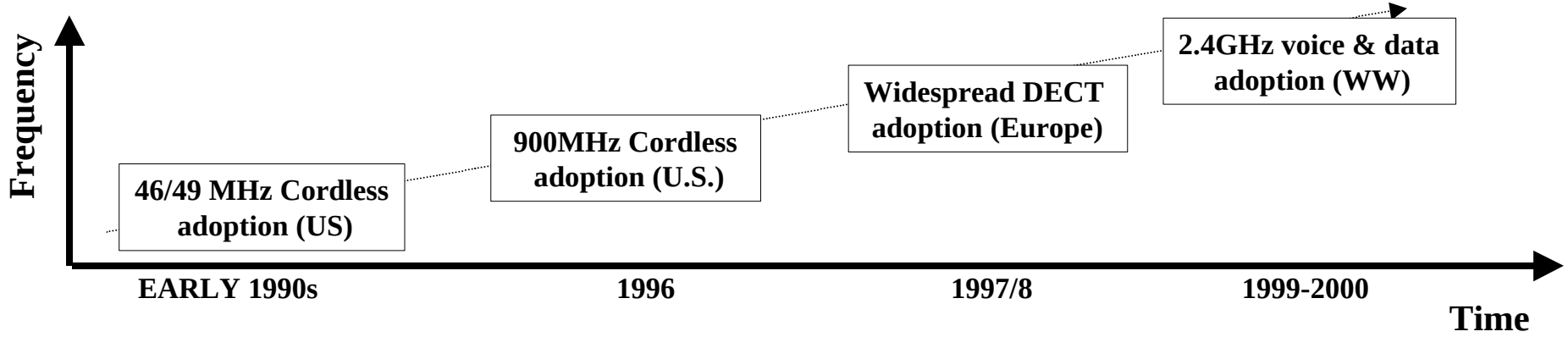
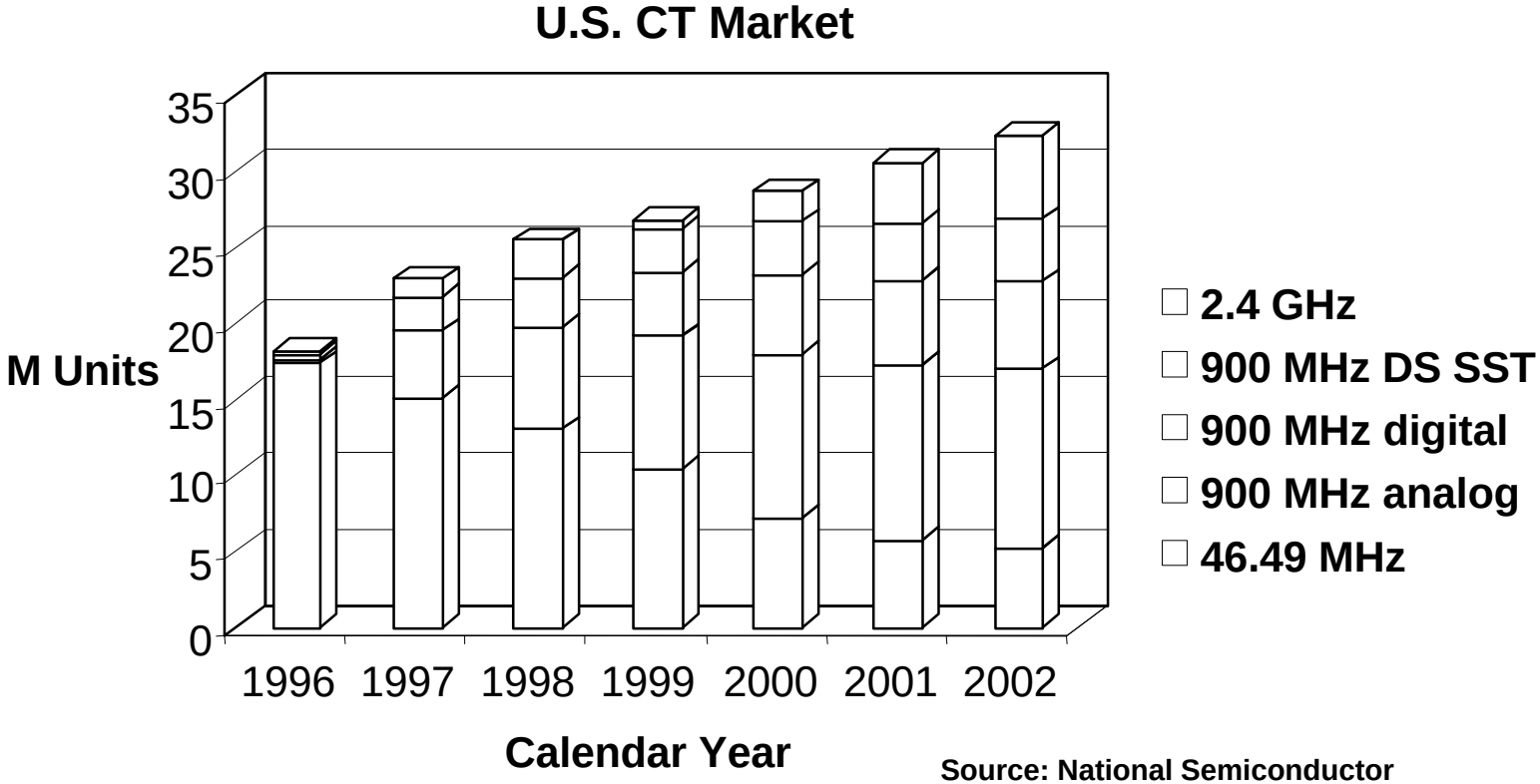
Cordless Spectrum and Market Adoption





U.S. Cordless Phone Market

U.S. Cordless Phone Shipments



Source: National Semiconductor

But voice is only part of the picture now!

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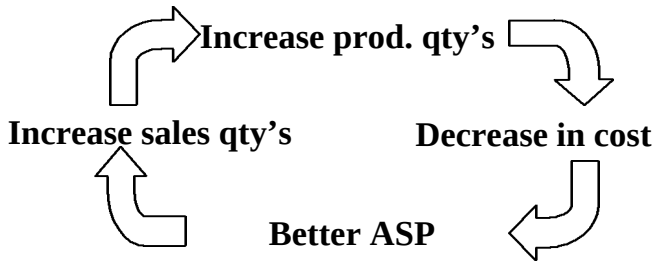
Growth Drivers In the Cordless Market

- **The lesson of DECT**
  - **DECT success is driven by residential market**
  - **Economies of scale**
    - **75M DECT terminals sold in CY2000!**
    - **German market → Central Europe → Europe**
    - **Cost focus demanded already multiple generations of IC solutions**
    - **DECT phone ASP from $250 in 1995 to $110 in 1999**
      - **In large part due to BOM improvements**



Can the same happen for 2.4GHz?

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Additional Considerations At 2.4GHz

- **Voice is only half the story today**
  - **Data capabilities are needed**
  - **2.4GHz provides added bandwidth capabilities over lower frequencies**
  - **Already being used for WLAN applications**
- **2.4GHz spectrum availability is global**
  - **Unlike 1.9GHz DECT (Europe)**
  - **Unlike 900MHz ISM (U.S.)**

So what about DATA?

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Wireless LAN Standards

Wireless LAN Standards

Wireless LAN Standards	Targeted Applications	Distinctive Characteristics	Modulation/ Frequency	Product Availability	Specification Owner	Certification Owner	*Primary Users*
OpenAir™	Mobile data, Networking	Small, light, inexpensive, Low Power Scalable, Established Compatibility	FH 1.6Mbps, 2.4GHz	Today	WLIF	WLIF	*Commercial*
802.11 FH	Wireless data networking	Defines encryption option, IEEE Sanction	FH 2Mbps, 2.4GHz	Today	IEEE	UNH*	*Commercial*
802.11 DS	Wireless data networking	Defines encryption option, IEEE Sanction	DS 2Mbps, 2.4GHz	Today	IEEE	UNH*	*Commercial*
HiperLAN	High Speed, Multimedia wireless LANs	High Speed. Large capacity; Desgins to support voice, video, data	GPSK 24Mbs, 5GHz	later 1999	ETSI	ETSI	*Commercial*
SWAP	Wireless communications in home and SOHO	Low Cost, supports voice, no multi-cell roaming	FH 2Mbps, 2.4GHz	later 1999	HomeRF Working Group	HomeRF Working Group	*Consumer*
Bluetooth	Short range cable replacement	Very low cost structure; Supports voice and data; Short range	FH 1Mbps, 2.4GHz	later 1999	Bluetooth SIG	Bluetooth SIG	*Consumer*

* Not formally part of the IEEE charter

Source: WLIF

Let's look at a couple of these in more detail

Proposed Home Networking/SOHO Connectivity Technologies

Wired

- **HomePNA (1/10 Mbps)***
- **Traditional Cat5 Ethernet**
- **USB**
- **HAVi / IEEE 1394 (FireWire)**
- **Power Line***
- **Coax / CATV**

**** = "no new wires"***

Wireless

- **802.11**
- **HomeRF**
- **Bluetooth**
- **Up-banded DECT**
- **2.4GHz ISM band products**

All are "no new wires"

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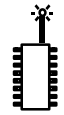
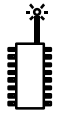


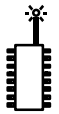
What Is Bluetooth?

- **Industry consortium promoting an open specification for a small, inexpensive, short-range radio**
  - **GSM/cell phone handset link**
  - **RF replacement for IRDA**
  - **Overcomes IRDA's line-of-sight restrictions**
- **Operates in unlicensed 2.4GHz ISM band**
- **10 meter range**
- **Supports both data and voice**
  - **Data speeds up to 721 Kbps**
  - **Up to 3 voice channels**



Applications

- **Automatic activation of “hands-free” cell phone use in your car**
- **Cell phone-to-mobile PC link**
  - **Automatic email exchange on mobile PC via cell phone**
- **Wireless data synchronization between hand-held computer and mobile PC**
  - **Palm Pilot to ThinkPad**
- **Ad-hoc networking**
  - **Simultaneous PowerPoint viewing**
  - **Workgroup sharing**



Bluetooth goal – wireless link between all mobile devices!

What is HomeRF?

- **Wireless LAN based on 802.11 and DECT**
- **Operates in 2.4GHz ISM band**
- **300 ft. range (radius) in and around the home or small office**
- **Simultaneous data and voice**
  - **1.5 Mbps**
  - **6 voice channels**
- **Cost target: $30**
- **Products due end of CY99**

HomeRF™

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Home Networking Conclusions

- **Key to success in home networking is understanding consumer behavior**
- **Impulse price points necessary for mass market**
  - **$20-50 “bits to antenna” to be competitive**
- **A mix of technologies will be required**
  - **HomePNA wired backbone**
  - **Wireless sub-network**
    - **2.4GHz ISM band solutions will be dominant**
      - **Bluetooth**
      - **802.11**
      - **HomeRF**
      - **Non-standard**

So where can we get cost-effective, off-the-shelf 2.4GHz radio solutions to build products for these emerging markets?

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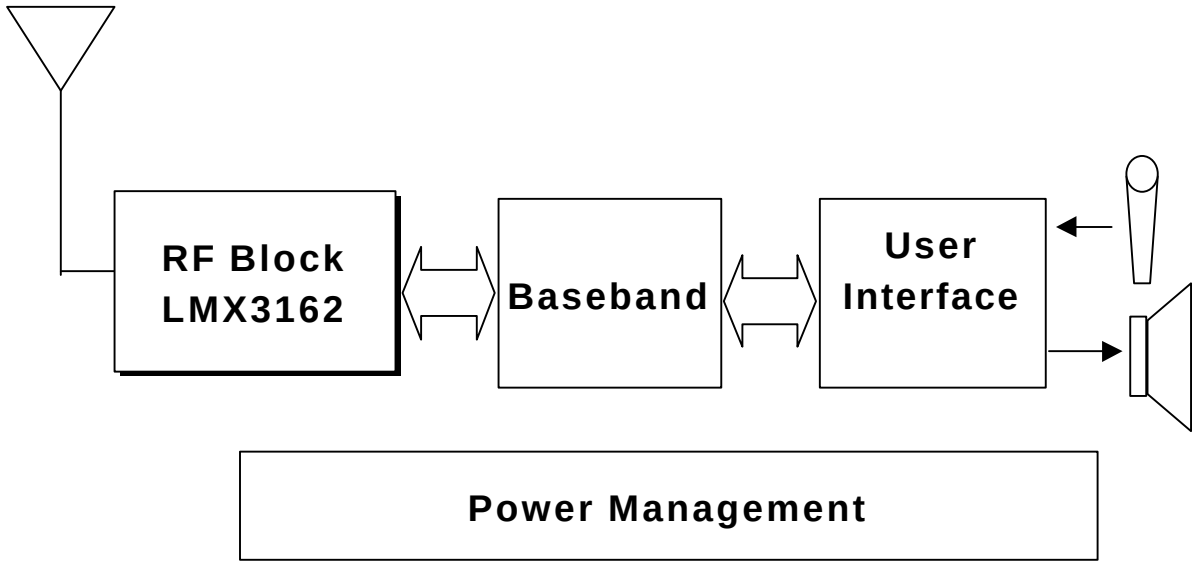
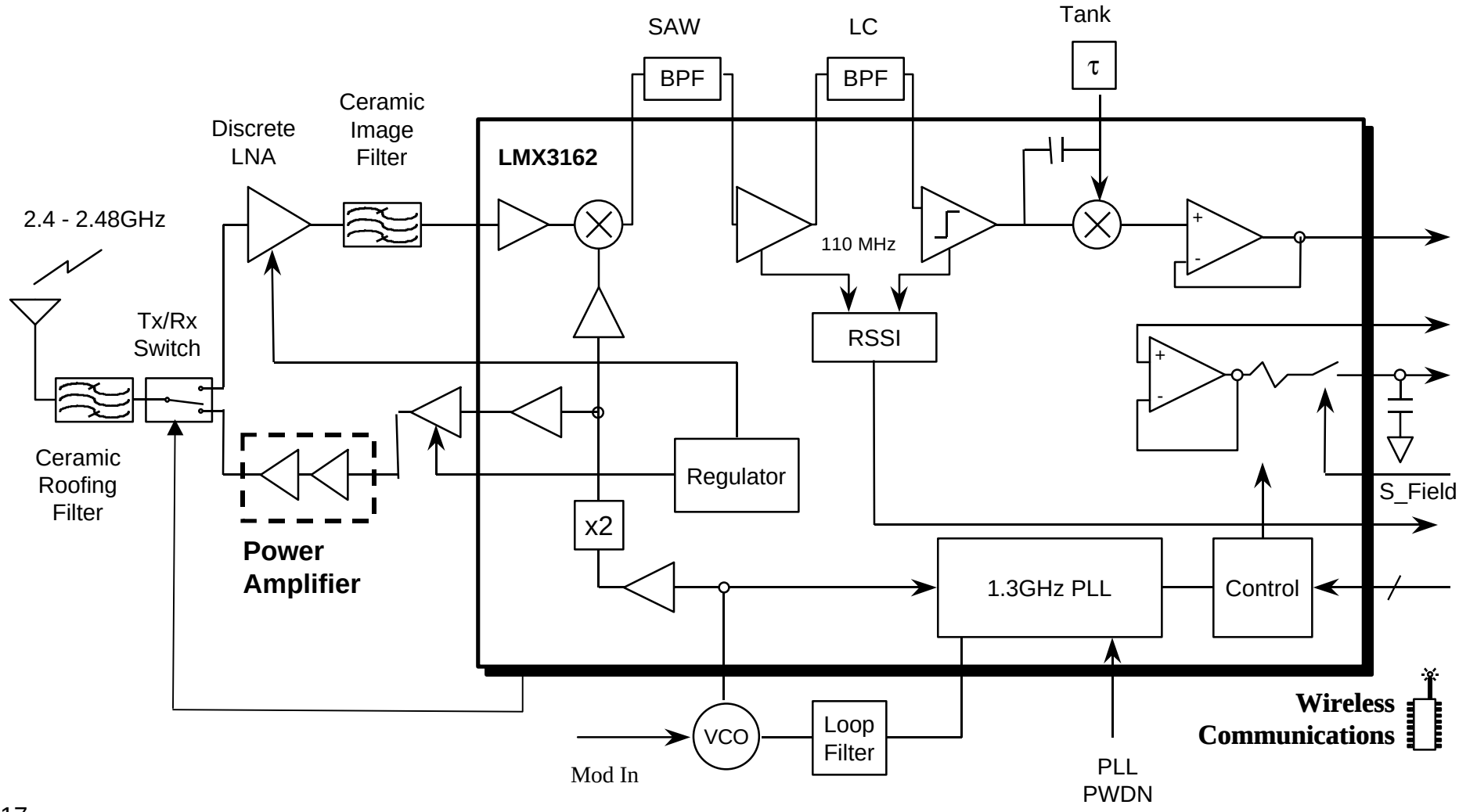
LMX3162 RF Transceiver

- **Enabling fast time to market for emerging 2.4GHz applications**
- **Based on proven technology**
- **Production/samples available now**



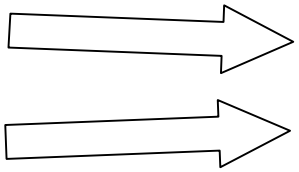
Wireless
Communications

LMX3162
2.4GHz Transceiver



LMX3162 RF Transceiver

- **Features:**
  - **Single chip solution for ISM 2.4GHz RF transceiver**
  - **RF sensitivity to -93dBm; RSSI sensitivity to -100dBm**
  - **Two regulated voltage outputs for discrete amplifiers**
  - **High gain (85 dB) intermediate frequency strip**
  - **Allows unregulated 3.0V-5.5V supply voltage**
  - **Power down mode for increased current savings**
  - **System noise figure 6.5 dB (typical)**
- **Benefits:**
  - **Small size (integration)**
  - **Cost-effective solution**



Enabling 2.4GHz Applications

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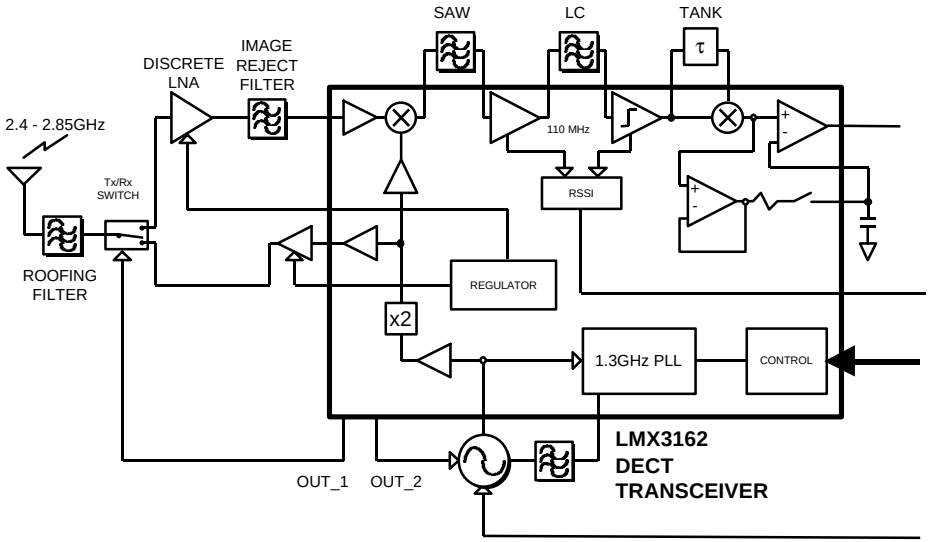
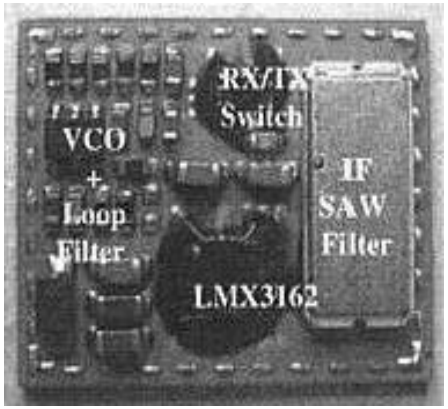
National's Bluetooth Radio (Technology Demonstrator)





- All-In-One Radio Module
- External components integrated in Low Temperature Co-fired Ceramic (LTCC)
- Target size: 12.5 x 12.5 x 2 mm

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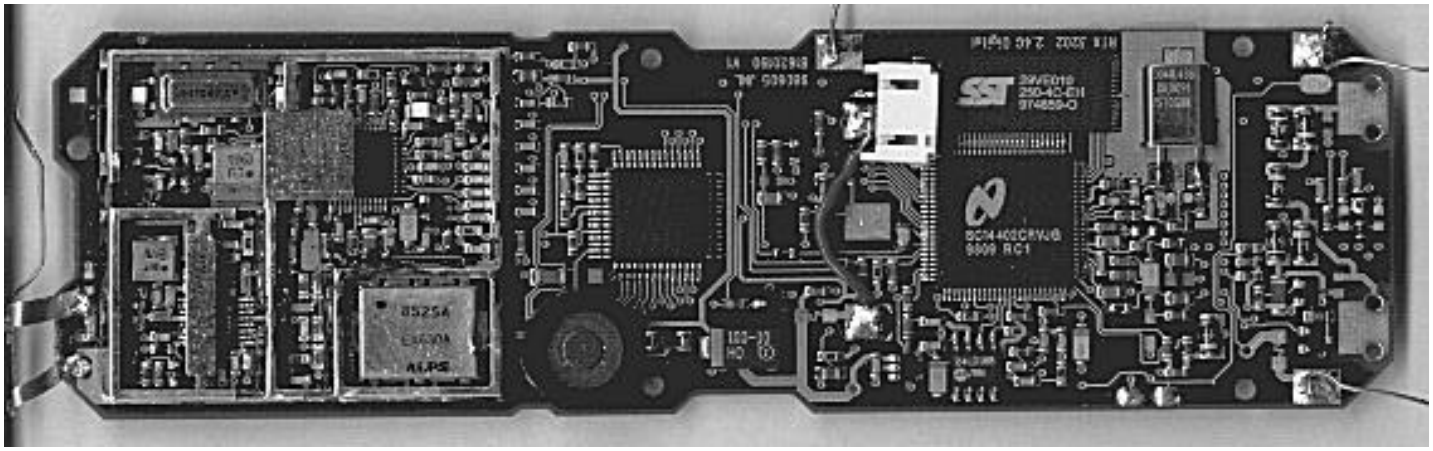
2.4GHz Cordless Handset



Using LMX3162 radio and National Semiconductor baseband solution

- DECT protocol in the 2.4GHz band
- Feasibility studies completed, customers are introducing products this year
- Microwave oven interference can be avoided
- TDMA Controller same as for DECT
- Higher layer protocols same as DECT
- 2.4 GHz band … available worldwide

Country	Frequency Range	RF Channels	
Europe* & USA	2400 - 2483.5 MHz	$f = 2402 + k$ MHz	$k = 0,\ldots,78$
Japan	2471 - 2497 MHz	$f = 2473 + k$ MHz	$k = 0,\ldots,22$
Spain	2445 - 2475 MHz	$f = 2449 + k$ MHz	$k = 0,\ldots,22$
France	2446.5 - 2483.5 MHz	$f = 2454 + k$ MHz	$k = 0,\ldots,22$

Table 2.1: Available RF channels

*. except Spain and France

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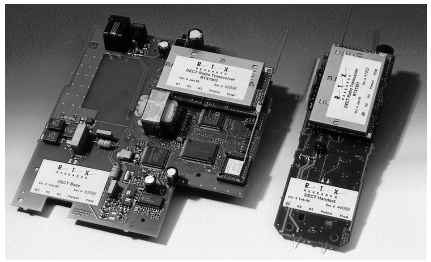
Complete DECT and 2.4GHz Solutions via Our System Integrator Partner RTX



DECT & 2.4GHz Reference Designs

- *Schematics*
- *Layouts*
- *Software*
- *Documentation*

- **RTX "MARS" Program using LMX3162**
  - **MARS is the project for the development of 2.4GHz wireless technology at RTX Telecom A/S**
  - **Based on the proven DECT technology**
  - **Hardware, software and IPR's developed by RTX**
  - **Offers standard products based on the RTX3202 platform plus optional customization**
  - **Offers standard products for wireless data based on the RTX6201 Platform plus optional customization**
- **MARS Basic Cordless Phone**
  - **Standard Product (RTX3202) for rapid market entry**
  - **High capacity: up to 9 simultaneous connections**
  - **Three-party conversation possible**
  - **Intercom**
  - **Protocol based on proven DECT GAP stack**
  - **Microwave oven Interference Avoidance algorithm**
  - **Low-cost BOM, based on low-cost standard DECT ICs**
  - **Customized versions possible**

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Product Roadmap

- **Cost reduction options, using optimized process partitioning**
- **Integration options, possibly using LTCC technology**
- **Customization for customer- or market-specific opportunities**

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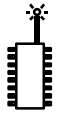

Summary

- **National's LMX3162 provides an off-the-shelf, highly integrated radio solution for voice and wireless data existing and emerging 2.4GHz applications**
  - **Leverages DECT experience and technology**
  - **Leverages PLL expertise and proven track record**
  - **Enables world-wide system solutions using 2.4GHz ISM band**
  - **High volume production capability NOW**
  - **Based on proven, high performance, cost-effective technology**

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