Firmware-Driven Bluetooth ATE (Automated Test equipment) Test Optimization

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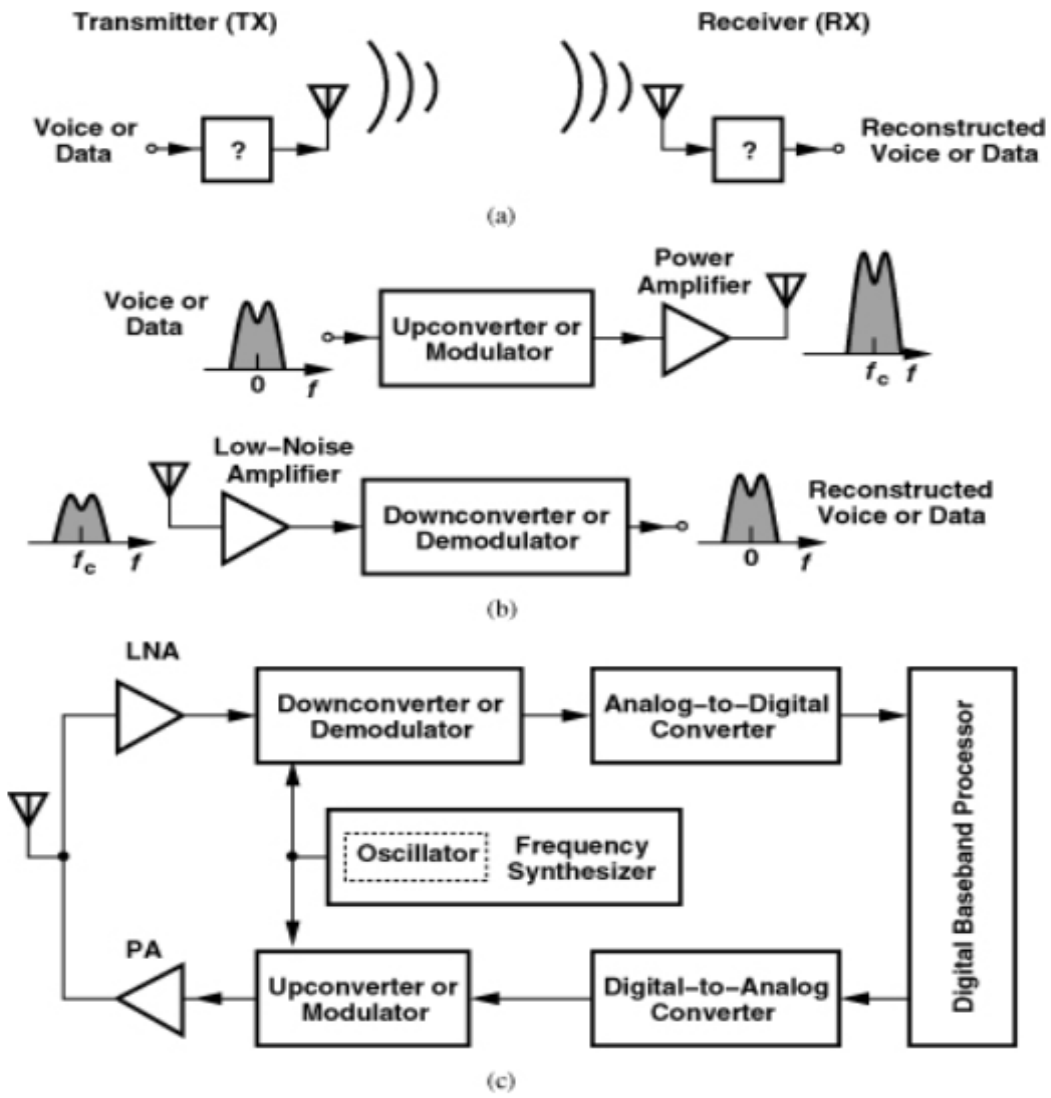
OUTLINE

To evaluate the efficiency of Bluetooth test methodologies in ATE (Automated Test equipment) Manufacturing Environment.

- RF Testing Background
- Test Flow comparison
- Pros and Cons
- Yields and Test time comparison
- Summary

Basic RF Block Diagram and Standard

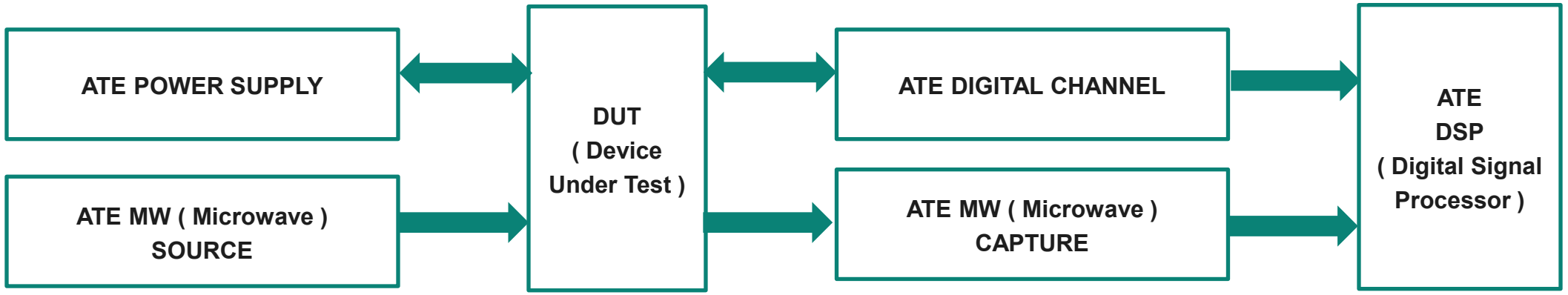


Parameter	BT / BLE	WLAN
Connection	Device to Device	Device to Router
Frequency	2.4Ghz	2 GHz, 5GHz, 6GHz, 7GHz
Bandwidth	1Mhz	20Mhz, 40Mhz… 320Mhz
Modulation	GFSK, 8QPSK	QAM
Data Rate	1Mbps, 2Mbps, 3Mbps	1Mbps, 11Mbps, 54Mbps, 1300Mbps
Range	30ft	300ft
Transmission	Frequency hopping	DSSS, OFDM, MIMO

ATE (Automated Test Equipment) Test Setup

What are the parameters we are trying to quantify by ATE testing ? Performance test specification outlined by the Bluetooth Special Interest Group (SIG)

- TX Power, ACP (Adjacent Channel power)
- DEVM (Differential Error Vector Magnitude)
- Modulation characteristics
- RX PER (Receiver packet error rate)
- RSSI (Receiver signal sensitivity)



Test Flow Comparison

Tester Specific Pattern-Based Flow

Execute the calibration tests first

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Use patterns to Set up the Tx or Rx modes by writing to the registers.

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Use patterns to generate transmission packets from the Device Under Test

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ATE captures the transmission waveform for post-processing.

Firmware-Based Flow

Download the firmware to On on-chip Memory

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Communicate using UART HCI commands to set Tx or Rx modes.

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Use HCI commands to generate transmission packets from the Device Under Test

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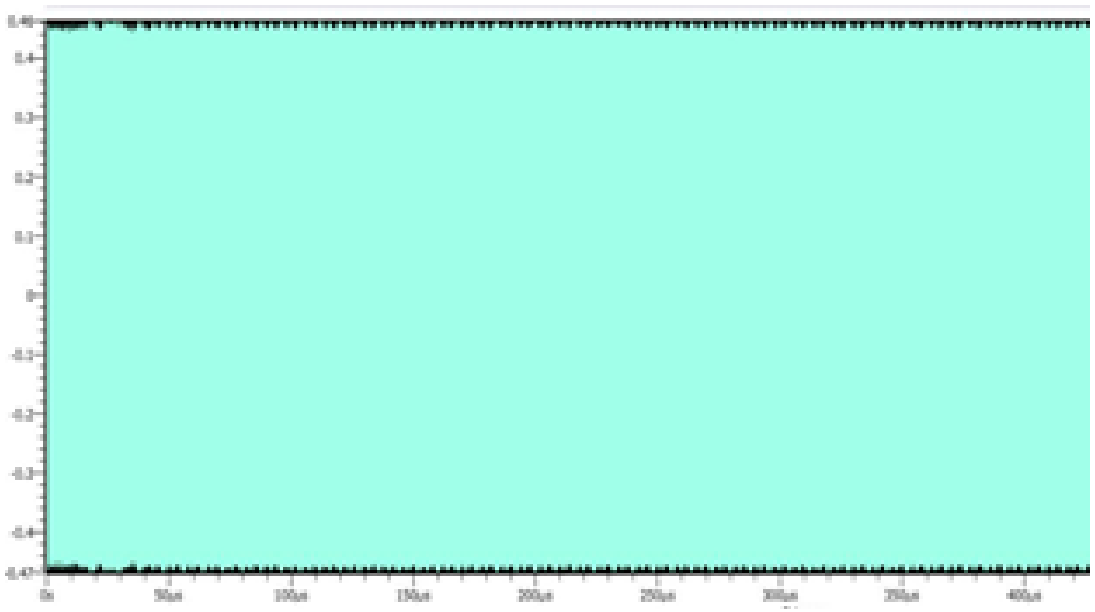
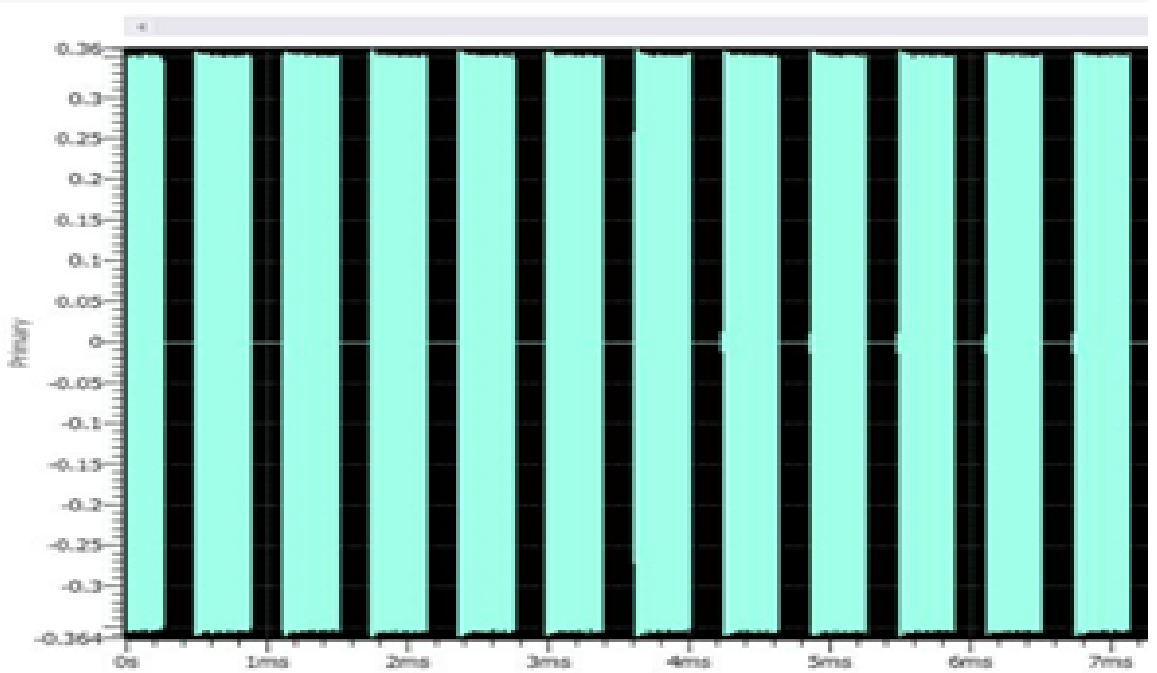
ATE captures the transmission waveform for post-processing.

Pattern Based Testing Captured BLE Wave



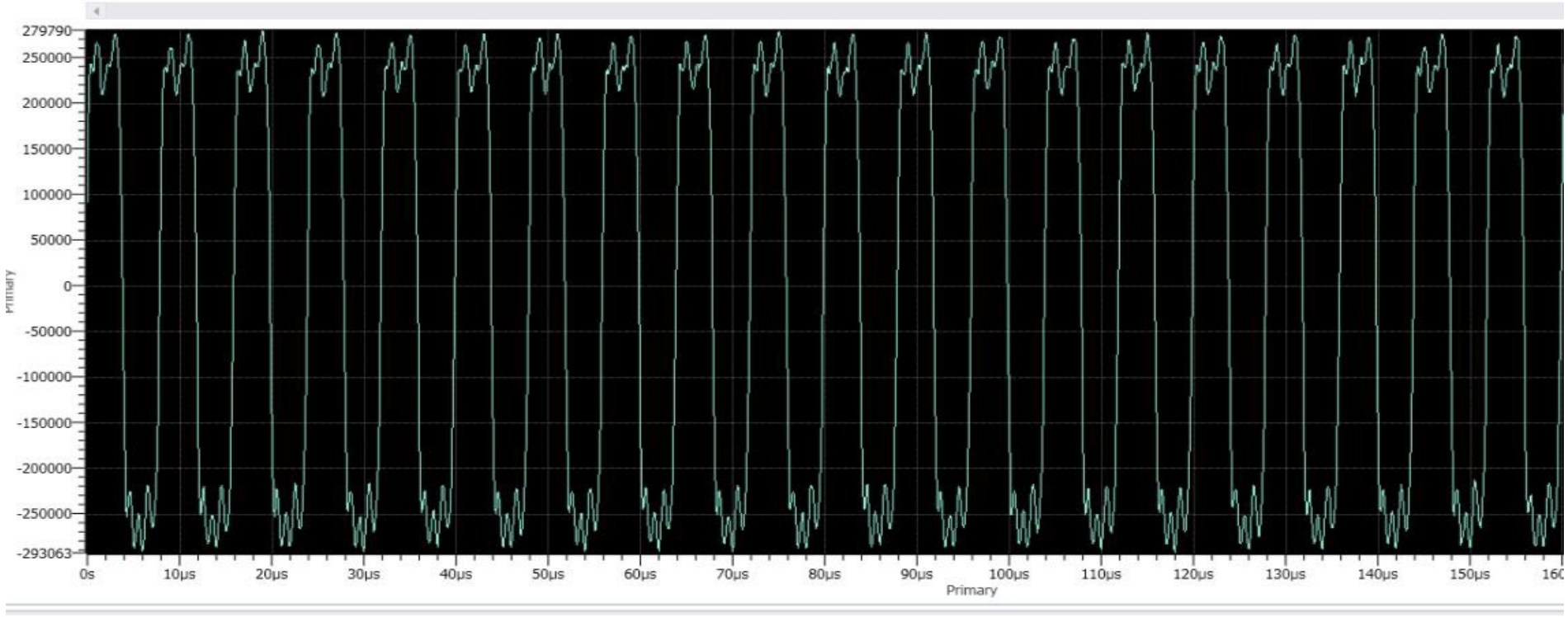
Synchronous captured Tx13 mode. X-axis is time in msec Y-axis is Amplitude in volts

Firmware Based Testing Captured BLE Wave



Asynchronous captured Tx 13 mode. X-axis is time in msec Y-axis is Amplitude in volts

Demodulated BLE Output (11110000 data input)



GFSK demodulated waveform. X-axis is Time in usec Y-axis is frequency deviation value in Hz.

Pros and Cons

	Pattern-Based	Firmware-Based
1	Longer Cycle times for Test development	Short Cycle time for Test development
2	Coding for Calibrations required	Calibrations are part of Firmware
3	Lower Yields and Higher Test Time	Better Yields and Test Time
4	Bench to ATE correlation is difficult	Bench to ATE correlation is easy
5	Not the same as Customer Setup	Same as Bench / Customer setup
6	Synchronous capture, no frame extraction	Asynchronous capture requires Frame extraction in post-processing

Yields and Test Times

Test / Failures (%)	Pattern Based	Firmware Based
Tx Power and Devm	5%	0.05%
Tx Modulation char	5%	0.05%
Total Yield Loss	10%	0.10%

Test / Test Time / Dut (sec)	Pattern Based	Firmware Based
Setup	1.4 Sec	1.1 Sec
Tx Tests	7.5 Sec	2.6 Sec
Total Test Time / Dut	8.9 Sec	3.7 Sec

SUMMARY

This work evaluates Firmware-based and Pattern-based approaches for Bluetooth in ATE (Automated Test equipment) Manufacturing Environment.


Infineon