

Pratap Tumkur Renukaswamy · Nereo Markulic ·
Jan Craninckx

PLL Modulation and Mixed-Signal Calibration Techniques for FMCW Radar

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 Springer

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Pratap Tumkur Renukaswamy

Contents

1 Introduction	1
1.1 Frequency-Modulated Continuous-Wave (FMCW) Radar	1
1.1.1 Chirp Nonlinearity Characteristics	4
1.1.2 Chirp Synthesizer Phase Noise	5
1.2 An Open Loop Versus a Closed Loop Chirp Synthesis	8
1.2.1 PLL Fundamentals	10
1.3 Charge Pump (CP)-PLL	11
1.3.1 Phase Domain Model of CP-PLL	12
1.4 Sub-Sampling Phase-Locked Loop (SSPLL)	15
1.4.1 Phase Domain Model of SSPLL	18
1.5 Least-Mean-Square (LMS)-Based Calibration	19
1.6 Motivation and Research Objectives	21
1.7 Outline of the Book	22
1.8 Recognition of Technical Contributions	24
References	24
2 A 10 GHz Sub-Sampling PLL Chirp Synthesizer Using a Charge-Integrating DAC	29
2.1 QDAC-Based Frequency Modulator	33
2.1.1 QDAC Versus VDAC for Frequency Modulation	36
2.1.2 QDAC Versus Switched Capacitor DAC for Frequency Modulation	39
2.2 Nonlinearity Calibration	40
2.3 Design Implementation	46
2.4 Key Building Blocks	47
2.4.1 DTC	49
2.4.2 QDAC Design	50
2.4.3 VCO	52

2.4.4	VCO Buffer and Sampler	53
2.4.5	G_m Stage and Sign Extraction	54
2.4.6	Loop Filter	56
2.4.7	FLL	57
2.5	Measurement Results	60
2.6	Conclusion	70
References	70
3	A 16 GHz Duty-Cycled Charge Pump PLL-Based Chirp Synthesizer	75
3.1	CP-PLL FMCW Modulator	78
3.2	Phase Error Sign Extraction	79
3.2.1	DC Phase Offset Effects in Sign-Sign LMS Algorithm	81
3.2.2	A DTC Assisted TDC-Based Sign Extraction	84
3.3	System Implementation	87
3.4	Key Building Blocks	90
3.4.1	POC-DTC	91
3.4.2	TDC	92
3.4.3	MMD	93
3.4.4	Charge Pump (CP)	95
3.4.5	PFD	96
3.4.6	Loop Filter	96
3.4.7	VCO	97
3.4.8	Lock Detector and VCO Coarse Tuning	98
3.5	PLL Duty Cycling	100
3.6	Measurement Results	100
3.7	SSPLL Versus CP-PLL for Duty-Cycling	111
3.8	Conclusion	116
References	116
4	FMCW Chirp Frequency Error and Phase Noise Measurement	123
4.1	Chirp Characteristics	125
4.2	Measurement Setup	126
4.2.1	Instrument Frequency Accuracy Evaluation	126
4.2.2	DUT Evaluation Setup	129
4.3	Chirp Linearity Measurement	130
4.4	Phase Error Measurement	135
4.4.1	Mono-Frequency Phase Noise	135
4.4.2	Phase Noise During FMCW Modulation	136
4.5	Radar System to Evaluate Chirp Profiles	140
4.6	Conclusion	141
References	141

5 Conclusion and Future Outlook	143
5.1 Summary of this Work	143
5.2 Key Contributions	144
5.3 Future Research Outlook	145
5.3.1 Fast-Locking Sub-Sampling Phase-Locked Loop (SSPLL) with a Lock Detector	146
5.3.2 Ring Oscillators for Chirp Synthesis	146
5.3.3 Nonlinear Chirp Waveform Synthesis for FMCW Radar	147
5.3.4 Radar LO Generation, Transmission and Reception Using PLL	148
References	151
 Appendix A: Fixed-Point Digital Design	 153

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Symbols

ω	Angular frequency in rad/s
α	Attenuation factor
C	Capacitance (F)
BW_{chirp}	Chirp bandwidth (Hz)
T_{chirp}	Chirp ramp time (s)
T_{CRI}	Chirp repetition interval (s)
T_{reset}	Chirp reset time (s)
I	Current (A)
f_{ref}	Frequency of reference clock (Hz)
f_m	Frequency offset from the carrier (Hz)
V_{SS}	Ground voltage (V)
$G(s)$	Open loop gain
r_{out}	Output resistance (Ω)
ϕ	Phase in radians (rad)
β	Phase-error detection gain
$\mathcal{L}(f)$	Phase noise in dBc/Hz
$S(f)$	Power spectral density
$f_{\text{BW,PLL}}$	PLL loop bandwidth (Hz)
ΔR	Range resolution (m)
c	Speed of light in vacuum (m/s)
V_{DD}	Supply voltage (V)
τ	Time delay (s)
T_{ref}	Time period of reference clock (s)
g_m	Transconductance (S)
σ^2	Variance
K_{VCO}	VCO gain in Hz/V
w_f	Windowing factor

Abbreviations

ADC	Analog to Digital Converter
ADPLL	All-Digital Phase-Locked Loop
BBPLL	Bang-Bang Phase-Locked Loop
BGA	Ball Grid Array
CML	Current-Mode Logic
CMOS	Complementary Metal-Oxide Semiconductor
CP	Charge Pump
DAC	Digital-to-Analog Converter
DCO	Digitally-Controlled Oscillator
DDFS	Direct Digital Frequency Synthesizer
DFC	Digital code to Frequency Conversion
DNL	Differential Nonlinearity
DSP	Digital Signal Processor
DTC	Digital-to-Time Converter
DUT	Device Under Test
DZ	Dead Zone
FFT	Fast Fourier Transform
FLL	Frequency-Locked Loop
FM	Frequency-Modulation
FMCW	Frequency-Modulated Continuous-Wave
FOM	Figure-of-Merit
FPNC	Feedforward Phase Noise Cancellation
GaAs	Gallium Arsenide
HPF	High-Pass Filter
IC	Integrated Circuit
IDAC	Current Digital-to-Analog Converter
IF	Intermediate Frequency
INL	Integral Nonlinearity
IO	Input/Output

LiDAR	Light Detection and Ranging
LMS	Least-Mean-Square
LNA	Low-Noise Amplifier
LO	Local Oscillator
LSB	Least Significant Bit
LUT	Look-Up Table
MIMO	Multiple-Input Multiple-Output
MMD	Multi-Modulus Divider
MMIC	Monolithic Microwave Integrated Circuits
mm-wave	Millimeter-wave
MOM	Metal-Oxide-Metal
MSB	Most Significant Bit
NF	Noise Figure
PA	Power Amplifier
PCB	Printed Circuit Board
PD	Phase Detector
PFD	Phase/Frequency Detector
PLL	Phase-Locked Loop
PM	Phase Margin
POC-DTC	Phase Offset Compensating Digital-to-Time Converter
PSD	Power Spectral Density
PVT	Process-temperature-voltage
QDAC	Charge-Integrating Digital-to-Analog Converter
RADAR	Radio Detection and Ranging
RCS	Radar Cross Section
RF	Radio Frequency
rms	Root mean square
RVCO	Ring Voltage-Controlled Oscillator
RX	Receiver
SiGe	Silicon-Germanium
SISO	Single-Input Single-Output
SNR	Signal-to-Noise Ratio
SoC	System-on-Chip
SPI	Serial Peripheral Interface
SPM	Single-Point Modulation
SSPD	Sub-Sampling Phase Detector
SSPLL	Sub-Sampling Phase-Locked Loop
TDC	Time-to-Digital Converter
TMN	Tunable Matching Network
TPM	Two-Point Modulation
TRX	Transceiver

TSPC	True Single-Phase Clock
TX	Transmitter
UWB	Ultra-wideband
VCO	Voltage-Controlled Oscillator
VDAC	Voltage Digital-to-Analog Converter
VHDL	Very high-speed integrated circuit Hardware Description Language

List of Figures

Fig. 1.1	FMCW radar transceiver and corresponding IF spectrum with targets at short and long distances	2
Fig. 1.2	Chirp INL a due to nonlinear tuning and b spur. c Chirp DNL	5
Fig. 1.3	Phase noise filtering due to range correlation in coherent radars for targets at 1 m, 50 m and 200 m	7
Fig. 1.4	IF signals corresponding to two targets due to PLL phase noise after range correlation	8
Fig. 1.5	Open loop chirp synthesis	9
Fig. 1.6	Closed loop chirp synthesis	9
Fig. 1.7	a CP-PLL block diagram. b Fractional-N mode timing diagram after phase-lock. c PFD-CP transfer characteristic	12
Fig. 1.8	Phase-domain small-signal model of the CP-PLL and illustration of important transfer functions	13
Fig. 1.9	a SSPLL block diagram. b Fractional-N mode sub-sampling operation by delaying the reference. c SSPD/ G_m -stage transfer characteristic together with the FLL	16
Fig. 1.10	Phase-domain small-signal model of the SSPLL	18
Fig. 1.11	DTC gain calibration using sign-sign LMS algorithm	20
Fig. 2.1	60 GHz FMCW radar architecture	30
Fig. 2.2	Single-point FMCW modulation (SPM): a reference modulation using DDFS, b divider modulus control, c modulation at phase detector output and d modulation at oscillator input	31
Fig. 2.3	Two-point FMCW modulation	32
Fig. 2.4	Proposed QDAC-based SSPLL frequency modulator	33
Fig. 2.5	FMCW modulation using a linear QDAC-based system	34
Fig. 2.6	a VDAC and b QDAC simplified schematics	36
Fig. 2.7	a Output noise of QDAC compared to VDAC. b IF output phase noise profile	38
Fig. 2.8	Linear phase domain model of SSPLL frequency modulator	38

Fig. 2.9	a QDAC plus varactor in a VCO for FM. b Switched capacitor DAC DCO for FM	40
Fig. 2.10	a K_{VCO2} versus V_{tune2} . b f_{VCO} versus time. c V_{tune2} versus time. d $D_{mod}[k]$ versus time. e DTC sampling in presence of nonlinearity	41
Fig. 2.11	Block diagram of DFC INL calibration	42
Fig. 2.12	DFC INL LUT update principle	44
Fig. 2.13	a Simulated DFC INL coefficients settling and their b final values	45
Fig. 2.14	V_{tune1} and V_{tune2} during delay-spread	46
Fig. 2.15	Block diagram of the QDAC-based FMCW SSPLL	47
Fig. 2.16	DTC architecture of [53]	49
Fig. 2.17	Simulated DTC phase noise	50
Fig. 2.18	QDAC schematic	50
Fig. 2.19	VCO schematic	52
Fig. 2.20	VCO buffer and sampler	53
Fig. 2.21	a G_m stage and sign extractor schematic with b timing diagram	55
Fig. 2.22	Sub-sampling path transfer characteristic	56
Fig. 2.23	SSPLL tunable loop filter	57
Fig. 2.24	Frequency divider with enhanced range and seamless $\Delta\Sigma$ divide modulus dithering	58
Fig. 2.25	Three-state PFD with a programmable dead zone	59
Fig. 2.26	FLL charge pump	60
Fig. 2.27	Die micrograph	60
Fig. 2.28	Measured SSPLL phase noise profile at in-band fractional offset	61
Fig. 2.29	Leakage on V_{tune2}	62
Fig. 2.30	Measured V_{tune1} and V_{tune2} progress with gear-shifting	64
Fig. 2.31	Measured V_{tune1} and V_{tune2} a without and b with pre-distortion	64
Fig. 2.32	a Measured K_{VCO2} versus V_{tune2} . b Estimated and measured DFC INL correction coefficients	65
Fig. 2.33	Measured FMCW chirp spectrum	65
Fig. 2.34	Chirp linearity measured at div/8 output with $T_{chirp} = 51.2 \mu s$ and $BW_{chirp} = 1.21$ GHz after DTC gain and DFC INL calibration	66
Fig. 2.35	Rms-frequency-error versus temperature variation for $T_{chirp} = 51.2 \mu s$ and $BW_{chirp} = 1.21$ GHz	67
Fig. 2.36	Rms-frequency-error versus supply variation for $T_{chirp} = 51.2 \mu s$ and $BW_{chirp} = 1.11$ GHz	67
Fig. 2.37	Chirp linearity measured at div/8 output with $T_{chirp} = 25.6 \mu s$ and $BW_{chirp} = 1.21$ GHz using C_{bat} for chirp reset	68
Fig. 2.38	Chirp linearity measured at div/8 output with $T_{chirp} = 12.8 \mu s$ and $BW_{chirp} = 1.21$ GHz using C_{bat} for chirp reset	68