4

“ ”

2019

5

5 2018 2022

1.

1.1

ICR

DSP driver TIA

BGA CFP2

QSFP-DD

-4dBm,

C -40~85 B2B

OSNR 10.5dB@100Gb/s QPSK,13dB@200Gb/s QPSK, 16dB@200Gb/s 16QAM, 21dB@400Gb/s DCI ,24dB@400Gb/s ZR

30

1.2

( )

100Gb/s

C+L

28GBaud/s

100Gb/s 1000

80 C+L

Hz

30

1.3 Pb/s (

)

-30dB

30

1.4

CMOS

- 50 dB

20 80

1

1.5

CMOS

Q [5]

100MHz-40GHz FSR

10GHz-200GHz 100Gb/s

-15dB

8

20 80

1.6 CDCG-ROADM

CDCG-ROADM

1×20 12.5GHz

2×1×20 6.25GHz

CDCG-ROADM

30

1.7 50Gb PON

50G

EML EML

DML

APD EML APD

PON

50Gb/s

(TIA) 50Gb/s

(LA) 50Gb/s

(CDR)

DML 50Gb/s

DML

50G EML 3dB

6dBm 50G APD 3dB 35GHz

-20dBm@1E-3 50G DML 3dB

6dBm ER 4dB O

50Gb/s TIA

GHz @ APD =22fF 50Gb/s LA

400mVpp

50Gb/s CDR

8ps-pp 400mVpp

50Gb/s DML

15ns 80mA 100mA

30

1.8 DFB PAM4 100G

PAM4

DFB

112Gb/s PAM4

112Gb/s

112Gb/s 10km

112Gb/s PAM4 QSFP
10km 1310nm
-1.4dBm OMAouter -6.1dBm@1E-3
DFB 3dB 1310nm
ER 3.5dB 3dB
112Gb/s PAM4 DFB
FEC
-3
30

1.9 CMOS

CMOS

CMOS

Tb/s ^{2}
ps 40

20 80

1.10

400Gb/s

400Gb/s 400Gb/s

400Gb/s

400Gb/s ZR

400Gb/s

-5dBm@BER 2E-4

-2dBm

400Gb/s

400Gb/s

56Gb/s 840~860nm

830~870nm

-7dBm@BER 2E-4

400Gb/s

MSA ZR

30

1.11 5G

5G

25Gb/s

5G

/

25Gb/s

-40~+90

dB $^{-5}$

-40~+85 Cyclic /

G.metro

±50pm

-25dB 25Gb/s

G.metro 20

5G

30

1.12 (

)

:

1550nm/1064nm -8

1550nm/1064nm

1550nm/1064nm

1550nm/1064nm

1550nm/1064nm

-43dBm@10Gb/s

30

1.13 ( )

-140dBc/Hz@10kHz

1525-1565nm

8 100 GHz

2/3

10^{-19}/

50ps

30

1.14 (

)

1×8 32×32

25GHz 200 6

DC-60GHz

-10dB

2/3 5~40GHz

1×8

32×32

DC-20GHz

2 40GHz

30

2.

2.1 (

)

III-V

Si III-V

Si III-V

)

512×4

^{12} cmHz$^{1/2}$/W

20 80

2.2 (

)

Si Ge LNOI

LNOI

LNOI

PIN APD

Si Ge

Si LNOI

LNOI

GHz LNOI V

dB

30

2.3

/

2

30

2.4

20 80

2.5

C+L

C+L

20

80

2.6

50 30

2.7 ( )

TOF

2.8 100G/400G (

)

100G/400G

100Gb/s 400Gb/s

VCSEL

Driver+CDR TIA+CDR

100G/400G

DFB Driver+CDR

TIA+CDR 400Gb/s

EML

Driver+CDR TIA+CDR PAM4

PAM4

PAM4 / 100Gb/s

200Gb/s

Driver

TIA

VCSEL 100Gb/s

28Gb/s 400Gb/s 56Gb/s

PAM4 6mA 6mA

DFB

100Gb/s 28Gb/s 400Gb/s

56Gb/s PAM4

30mA 30mA

EML

64Gb/s PAM4 Driver

700mV Driver

TIA

Driver TIA Driver TIA

30GHz Driver 400mV

Driver TIA

30dB

30

3.

3.1 MCU

MCU

MCU

CPU

MCU

200 MHz CPU

2 250

3

10 85

CAN 2.0A/B AEC-Q100 Grade 1

ECU

3.2

USB 4.0 DP 2.0 PCIe USB 2.0/3.0 DP USB 4.0 USB 4.0 DP 2.0 20 Gbps PHY 20 Gbps <1E-9 <100 mW/ 0.6% >24 dB USB 4.0 DP 2.0 PHY BIST PRBS31 80-bit FEC USB 4.0 DP 2.0 4 2 2 20 Gbps USB 4.0 DP 2.0 USB 4.0 PCIe USB 2.0/3.0 DP USB 4.0 USB 4.0 DP 2.0 USB 4.0

1000 3.3

NB-IoT GNSS SoC

CMOS

NB-IoT GNSS

SoC

CMOS

NB-IoT GNSS NB-IoT

GNSS

1.8 V ~ 4.2 V 700 MHz ~ 2.4 GHz NB-IoT

-117 dBm @ 180 kHz PSM 2 W,

65 mW 23 dBm GNSS

-146 dBm, -155 dBm

-158 dBm 3.5m

CEP, 1 10 mW NB-IoT

100

3.4

8 3

1 rms @

0.5-100 Hz 1 GΩ 70 dB

20 mV 0.5%

10 mΩ 90%

500 200 kbps 5

5 mW

24 1

3.5

90 MHz

-30~5 dBm 40 dB

±1 dB 20 dB ADC 10

200 MHz 90

MHz ±1 dB DAC

10 500 MHz

1

km

3.6 /

/ /

3.8 DRAM

AI

DRAM AI

DRAM

DRAM DRAM

DRAM AI

8 Gb

CNN DRAM

GPU TPU CNN

2

4.

4.1 EDA

EDA 1

AI EDA

2

EDA

3

4

7/5nm

1 AI EDA EDA

10% 2 0.5 VDD

3

5 4 500

5 20 50

5.

5.1

CMOS

3 nm

CMOS 100 nm 20 ns

0.1 pJ 10

1 Mb