



SUMITOMO ELECTRIC

01.08.28

◆ **Features**

- Up to 2.7 Gb/s (FEC available)
high speed operation
- Clocked (MS-D/FF) or Non-clocked
operation can be selected
- Disable function of modulation current
and bias current
- Bias current monitoring
- Mark density monitoring
- +5 V or -5 V single power supply
- Up to 60 mA p-p modulation current
- Up to 50 mA bias current
- Differential ECL compatible interface
- On-chip 50 Ω terminations
- Internal voltage reference for AC coupling

F0522501Q

2.7 Gb/s NRZ Data Rate

Laser Diode Driver



◆ **Applications**

- Laser diode driver of an optical transmitter circuit up to 2.7 Gb/s (FEC available)

◆ **Functional Description**

The F0522501Q is a high performance GaAs laser diode driver IC applicable in an optical transmitter circuit up to 2.7 Gb/s NRZ data rate (especially suitable for SDH [STM-16] / SONET [OC-48]) , featuring the capable operation for the FEC signal.

The F0522501Q specifies the rise time and the fall time of 70 ps (20 %-80 %) typically. It features the single +5 V or -5 V supply operation, the modulation current between 1 mA and 60 mA, and the bias current between 1 mA and 50 mA while the dissipating power is around the typical value of 1 W.

◆ **Absolute Maximum Ratings** $T_a = 25\text{ }^{\circ}\text{C}$, unless specified

Parameter	Symbol	Value	Units
Supply Voltage	$V_{DD}-V_{SS}$	- 0.5 to +7.0	V
Supply Current	I_{con}	250	mA
Input Voltage (D_{IN} , D_{INB} , CK_{IN} , CK_{INB})	V_{IN}	V_{SS} to $V_{DD}+0.5$	V
Input Voltage (DIS_{IN} , SEL_{IN})	V_{INC1}	V_{SS} to $V_{DD}+0.5$	V
Input Voltage (V_{MIN} , V_{BIN})	V_{INC2}	V_{SS} to $V_{SS}+1.5$	V
Output Voltage (OUT , OUT_B , OUT_{BIAS})	V_{OUT}	$V_{DD}-2.0$ to $V_{DD}+0.5$	V
Output Voltage (MRK , MRK_B , BM , BM_B)	V_{OUTM}	V_{SS} to $V_{DD}+0.5$	V
Termination Voltage (V_{TTD} , V_{TTCK})	V_{TT}	$V_{DD}-2.5$ to $V_{DD}+0.5$	V
Storage Temperature	T_{stg}	-55 to +125	$^{\circ}\text{C}$
Ambient Operating Temperature	T_a	0 to +70	$^{\circ}\text{C}$

◆ **Recommended Operating Conditions**

Parameter	Symbol	Value			Units
		Min.	Typ.	Max.	
Supply Voltage	$V_{DD}-V_{SS}$	4.75	5.00	5.46	V
Output Voltage	V_{OUT}	$V_{DD}-1.6$	$V_{DD}-1.0$	V_{DD}	V
Ambient Operating Temperature	T_a	0	25	70	$^{\circ}\text{C}$

◆ **Electrical Characteristics** $T_a = 25\text{ }^{\circ}\text{C}$, $V_{DD} - V_{SS} = 4.75\text{ to }5.46\text{ V}$

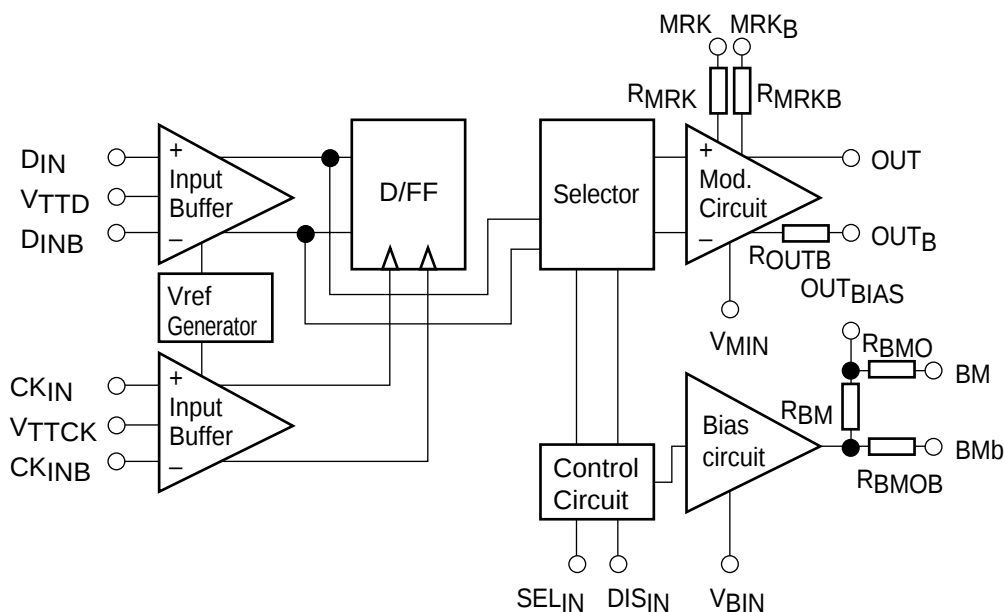
Parameter	Symbol	Test Conditions	Value			Units
			Min.	Typ.	Max.	
Circuit Current ⁽¹⁾	I_{CKT}	$V_{MIN} = V_{BIN} = V_{SS}$	-	100	130	mA
Input Voltage (ECL)	V_{IH}	Differential Input	$V_{DD} - 1.0$	$V_{DD} - 0.9$	$V_{DD} - 0.7$	V
	V_{IL}		$V_{DD} - 1.9$	$V_{DD} - 1.7$	$V_{DD} - 1.6$	V
Input Voltage (AC)	V_{IN}	Differential Input	0.6	0.8	1.2	Vp-p
Input Resistor	R_{IN}	-	-	50	-	Ω
Modulation Peak Current ⁽²⁾	I_{MMAX}	$V_{MIN} = V_{SS} + 1.5V$	60	-	-	mA
	I_{MMIN}	$V_{MIN} = V_{SS}$	-	-	1.0	mA
	I_{MDIS}	$V_{DISIN} = V_{DD} - 1.5V$	-	-	0.5	mA
Bias Current	I_{BMAX}	$V_{BIN} = V_{SS} + 1.5V$	50	-	-	mA
	I_{BMIN}	$V_{BIN} = V_{SS}$	-	-	1.0	mA
	I_{BDIS}	$V_{DISIN} = V_{DD} - 1.5V$	-	-	0.5	mA
Input Voltage (SEL)	V_{SELIH}	Non-Clocked op.	$V_{DD} - 1.5$	-	V_{DD}	V
	V_{SELIL}	Clocked opelation	V_{SS}	OPEN	$V_{SS} + 1.5$	V
Input Voltage (DIS)	V_{DISIH}	Disable opelation	$V_{DD} - 1.5$	-	V_{DD}	V
	V_{DISIL}	Enable opelation	V_{SS}	OPEN	$V_{SS} + 1.5$	V
Bias Monitor Resistor	R_{BM}		-	10	-	Ω
Mark Density Monitor Voltage	$\Delta(V_{MRK} - V_{MRKB})$	Differential Mode Data: All "H"	-	1.2	-	V
Rise Time ⁽³⁾	t_r	$RL = 15\Omega$ 20% - 80%	-	70	150	ps
Fall Time ⁽³⁾	t_f	$RL = 15\Omega$ 80% - 20%	-	70	150	ps
Setup Time	t_s		-	100	-	ps
Hold Time	t_h		-	50	-	ps
Maximum Clock Frequency	f_{max}	$V_{SEL} = \text{OPEN}$ or V_{SS} to $V_{SS} + 1.5V$	2.7	-	-	GHz
Maximum Data Rate	f_{opr}	$V_{SEL} = V_{DD} - 1.5V$ to V_{DD}	2.7	-	-	Gbps

(1) Excluding the input current, the modulation current and the bias current.

(2) Modulation peak current is measured at "OUT" pin.

(3) Rise time and fall time are measured at "OUT" pin.

◆ Block Diagram



◆ Pin Descriptions

- D_{IN} : Positive data input
- D_{INB} : Negative data input
- V_{TTD} : Termination for data input
- CK_{IN} : Positive clock input
- CK_{INB} : Negative clock input
- V_{TTCK} : Termination for clock input
- OUT : Positive modulation output (LD should be connected to this pin.)
- OUT_B : Negative modulation output ($R_{OUTB}=15\ \Omega$ typ.)
- OUT_{BIAS} : Bias output ($R_{BM}=10\ \Omega$ typ., $R_{BMO}=R_{BMOB}=3\ k\Omega$ typ.)
- V_{MIN} : Voltage input that sets the LD modulation peak current
- V_{BIN} : Voltage input that sets the LD bias current
- DIS_{IN} : Voltage input that controls turning on/off the modulation current and the bias current
- SEL_{IN} : Voltage input that selects clocked or non-clocked operation
- BM : Bias current monitor positive output
- BM_B : Bias current monitor negative output
- MRK : Mark density monitor positive output ($R_{MRK}=25\ k\Omega$ typ.)
- MRK_B : Mark density monitor negative output ($R_{MRKB}=25\ k\Omega$ typ.)

◆ Function Table

(1) Clocked Operation ($V_{IN}@SEL_{IN}=OPEN$ or V_{SS} to $V_{SS}+1.5V$)

Input		Output	
D_{IN}	CK_{IN}	Current@OUT	Current@OUTB
H	↑	ON	OFF
L	↑	OFF	ON
Φ	L	Q_O	Q_{OB}

↑ : Clock transition from low to high

Φ : Don't care

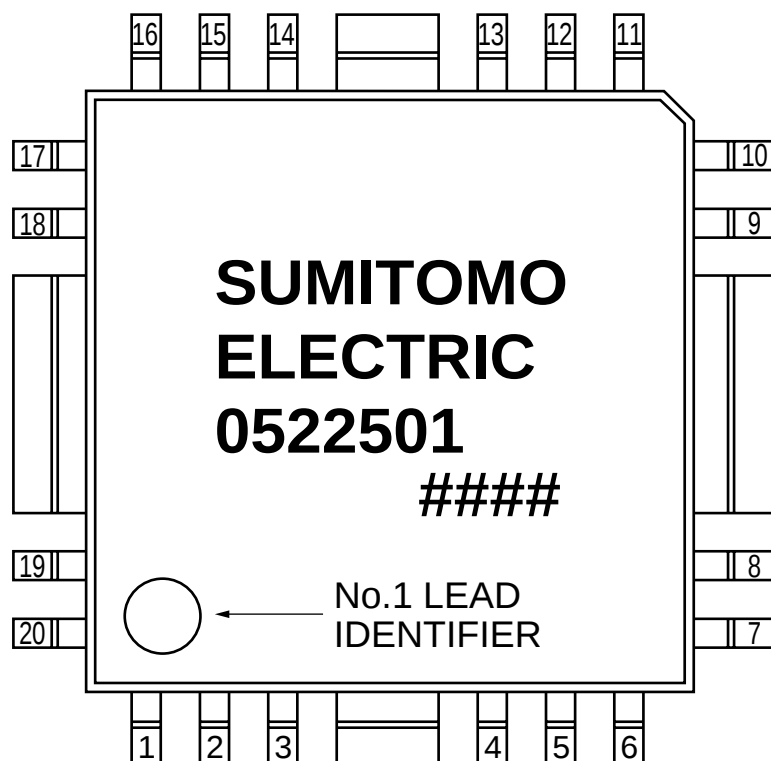
Q_O : Previous current output status @OUT before clock pulse

Q_{OB} : Previous current output status @OUTB before clock pulse

(2) Non-clocked Operation ($V_{IN}@SEL_{IN}=V_{DD}-1.5V$ to V_{DD})

Input		Output	
D_{IN}	CK_{IN}	Current@OUT	Current@OUTB
H	Φ	ON	OFF
L	Φ	OFF	ON

◆ Pin Assignments (Top View)



1 :D _{INB}	10 :BM _B	19 :MRK
2 :V _{TTD}	11 :BM	20 :DIS _{IN}
3 :D _{IN}	12 :OUT _{BIAS}	
4 :CK _{IN}	13 :OUT	
5 :V _{TTCK}	14 :OUT _B	
6 :CK _{INB}	15 :DNC	
7 :SEL _{IN}	16 :VM _{IN}	
8 :V _{DDC}	17 :VB _{IN}	
9 :V _{DDO}	18 :MRK _B	

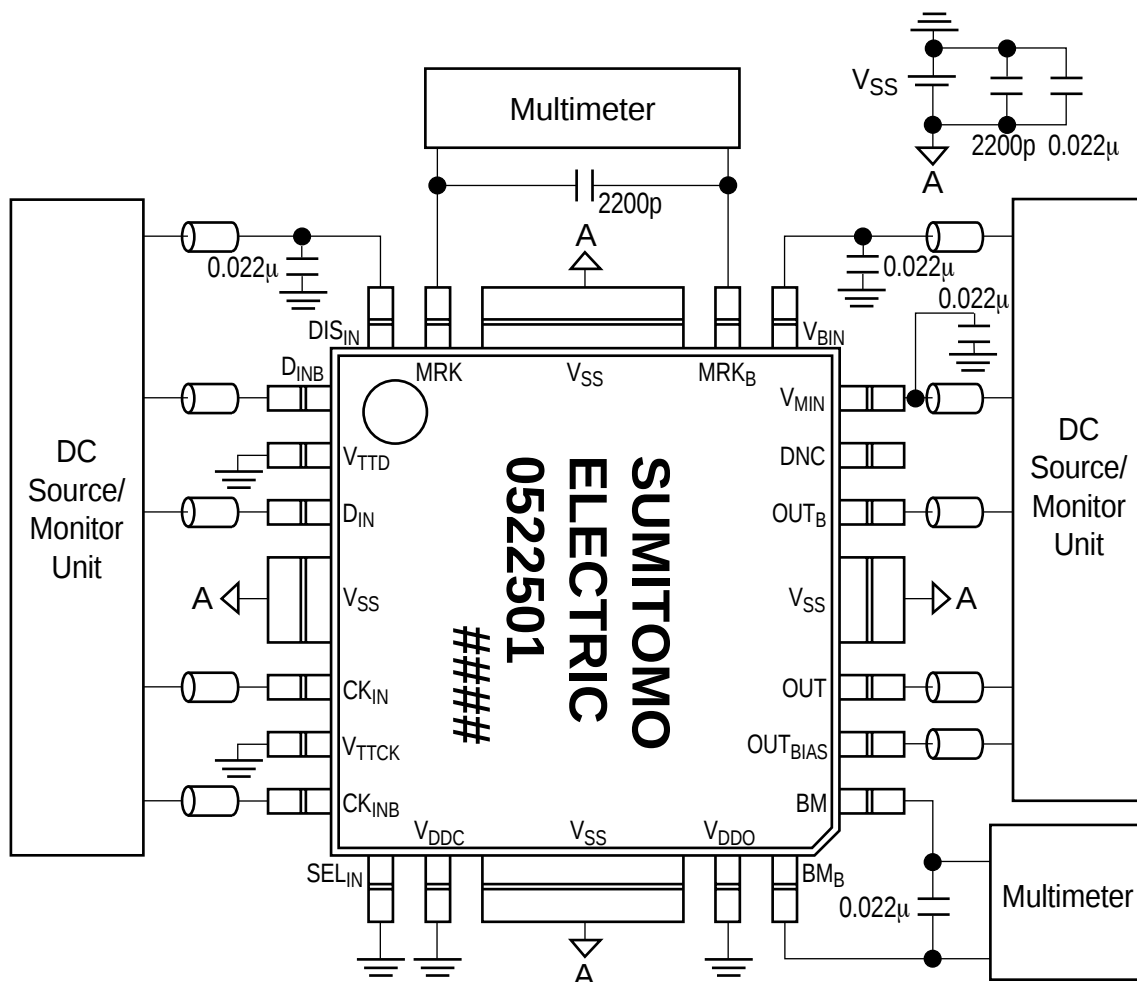
(*) The pins without numbering should be connected to V_{SS}.

(**) V_{DDC} and V_{DDO} are not connected internally.

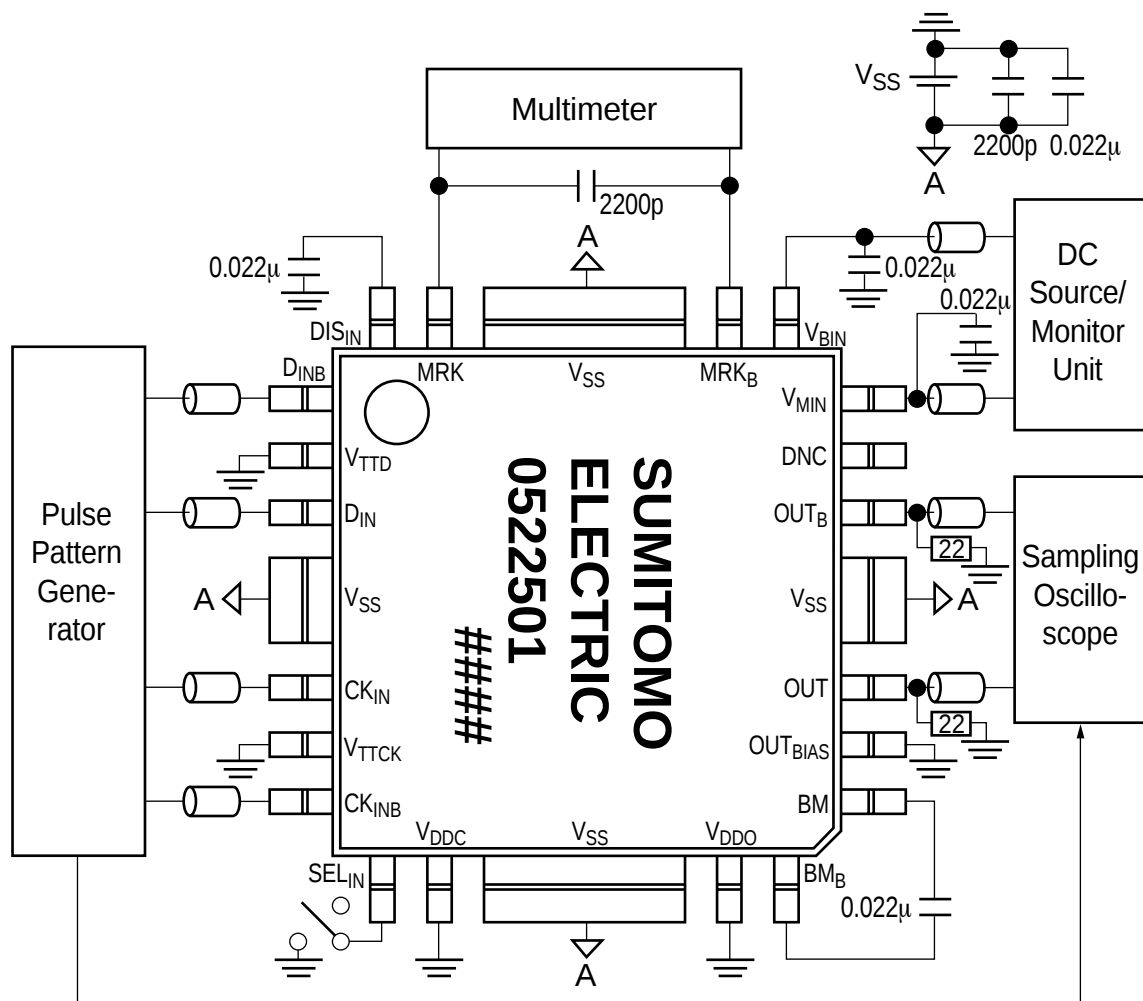
(***) DNC is a no user connection pin.

◆ Test Circuits

(1) DC Characteristics

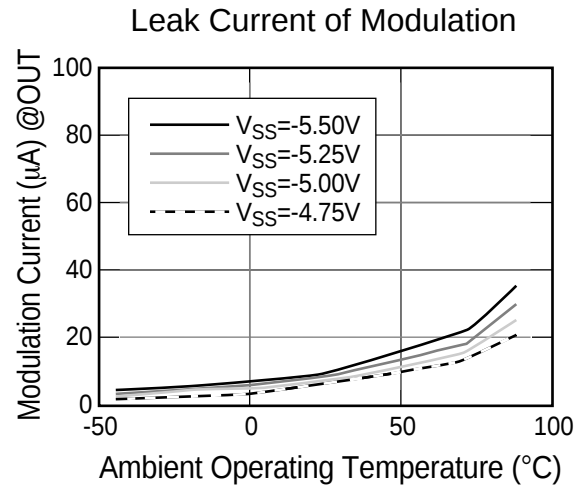
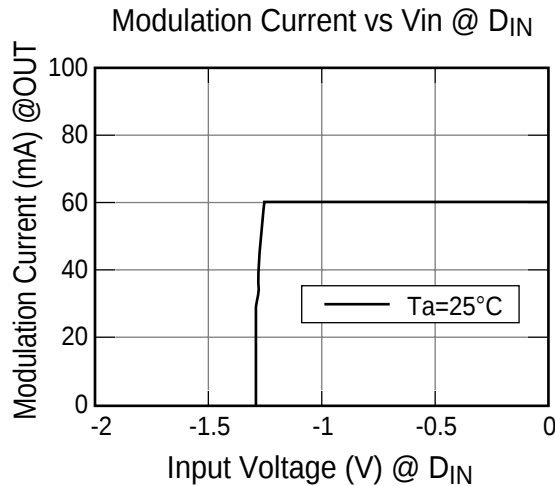


(2) AC Characteristics



◆ Typical Characteristics

(1) Modulation Current



Conditions

$V_{DD}=\text{GND}$, $V_{SS}=-5\text{ V}$, $V_{IN}@D_{INB}=-1.3\text{ V}$

$V_{MIN}@I_{Mpeak}=60\text{ mA}$, $V_{BIN}=V_{SS}$

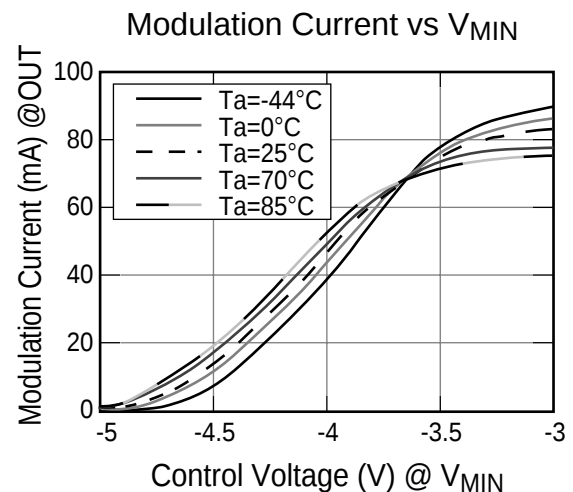
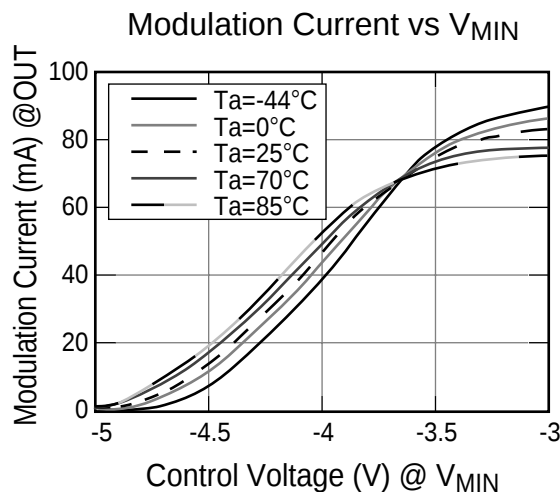
$V_{OUT}@OUT$, OUT_B , $OUT_{BIAS}=\text{GND}$

Conditions

$V_{DD}=\text{GND}$, $V_{IN}@D_{IN}=-1.6\text{ V}$, $V_{IN}@D_{INB}=-1.3\text{ V}$

$V_{MIN}@I_{Mpeak}=60\text{ mA}$, $V_{BIN}=V_{SS}$

$V_{OUT}@OUT$, OUT_B , $OUT_{BIAS}=\text{GND}$



Conditions

$V_{OUT}@OUT=\text{GND}$

$V_{DD}=\text{GND}$, $V_{SS}=-5\text{ V}$, $V_{IN}@D_{IN}=-1.0\text{ V}$

$V_{IN}@D_{INB}=-1.3\text{ V}$, $V_{BIN}=V_{SS}$

$V_{OUT}@OUT_B$, $OUT_{BIAS}=\text{GND}$

Conditions

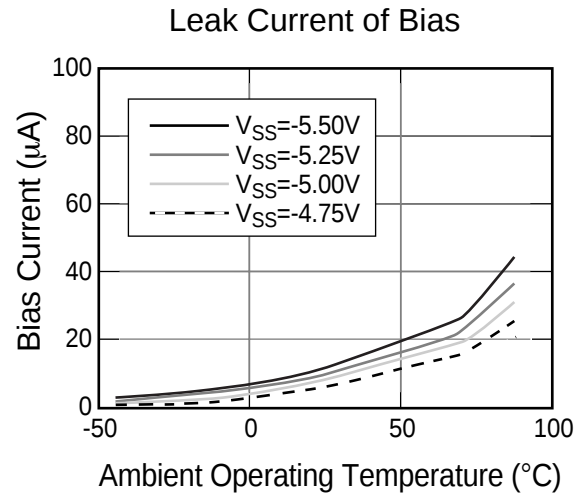
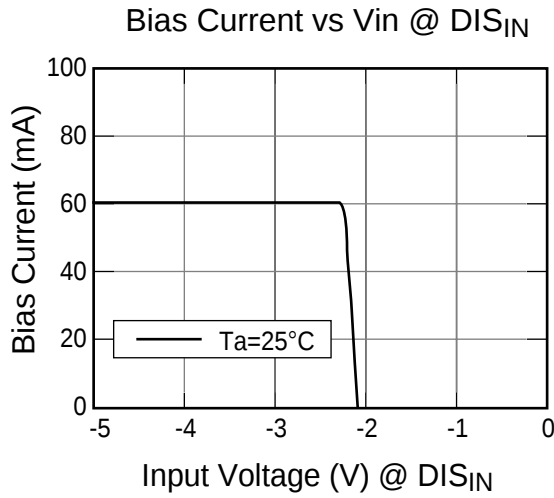
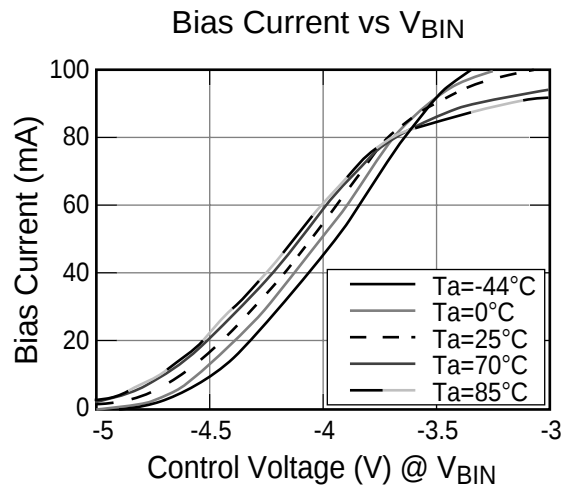
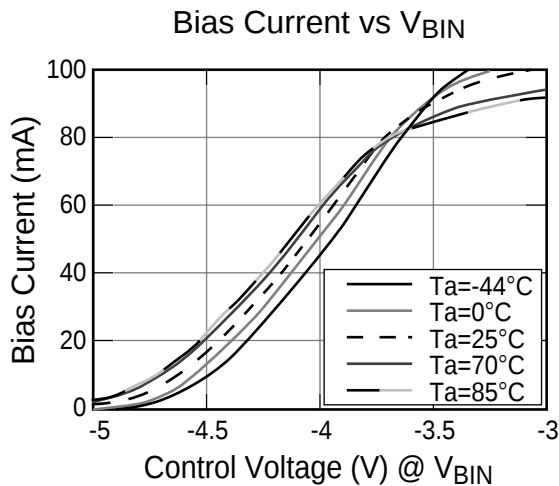
$V_{OUT}@OUT=-1.6\text{ V}$

$V_{DD}=\text{GND}$, $V_{SS}=-5\text{ V}$, $V_{IN}@D_{IN}=-1.0\text{ V}$

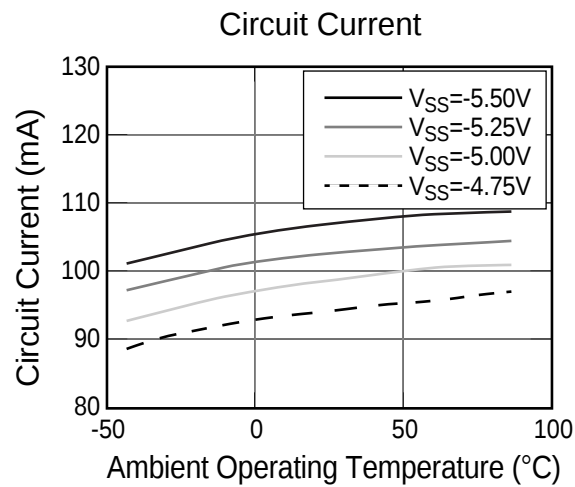
$V_{IN}@D_{INB}=-1.3\text{ V}$, $V_{BIN}=V_{SS}$

$V_{OUT}@OUT_B$, $OUT_{BIAS}=\text{GND}$

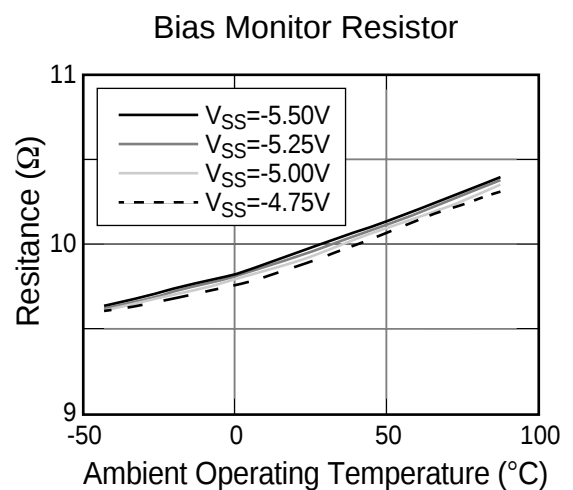
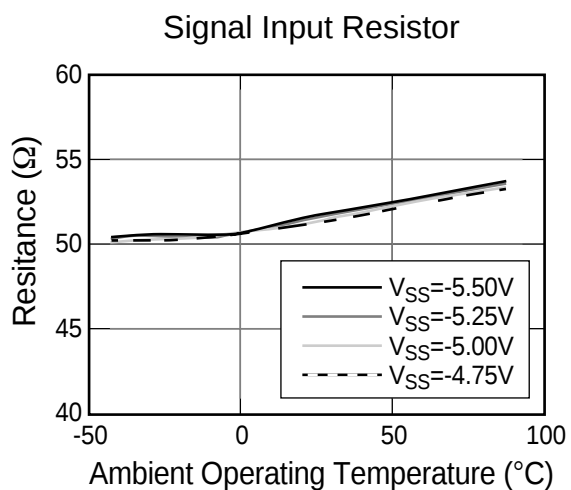
(2) Bias Current

Conditions
 $V_{DD}=\text{GND}$, $V_{SS}=-5\text{ V}$, $V_{IN}@D_{IN}=-1.0\text{ V}$
 $V_{IN}@D_{INB}=-1.3\text{ V}$, $V_{MIN}=V_{SS}$
 $V_{BIN}@I_B=60\text{mA}$
 $V_{OUT}@OUT$, OUT_B , $OUT_{BIAS}=\text{GND}$
Conditions
 $V_{DD}=\text{GND}$, $V_{IN}@D_{IN}=-1.0\text{ V}$, $V_{IN}@D_{INB}=-1.3\text{ V}$
 $V_{IN}@DIS_{IN}=-1.5\text{ V}$, $V_{MIN}=V_{SS}$
 $V_{BIN}@I_B=60\text{ mA}$
 $V_{OUT}@OUT$, OUT_B , $OUT_{BIAS}=\text{GND}$
Conditions
 $V_{OUT}@OUT_{BIAS}=\text{GND}$
 $V_{DD}=\text{GND}$, $V_{SS}=-5\text{ V}$, $V_{IN}@D_{IN}=-1.0\text{ V}$
 $V_{IN}@D_{INB}=-1.3\text{ V}$, $V_{MIN}=V_{SS}$
 $V_{OUT}@OUT$, $OUT_B=\text{GND}$
Conditions
 $V_{OUT}@OUT_{BIAS}=-1.6\text{ V}$
 $V_{DD}=\text{GND}$, $V_{SS}=-5\text{ V}$, $V_{IN}@D_{IN}=-1.0\text{ V}$
 $V_{IN}@D_{INB}=-1.3\text{ V}$, $V_{MIN}=V_{SS}$
 $V_{OUT}@OUT$, $OUT_B=\text{GND}$

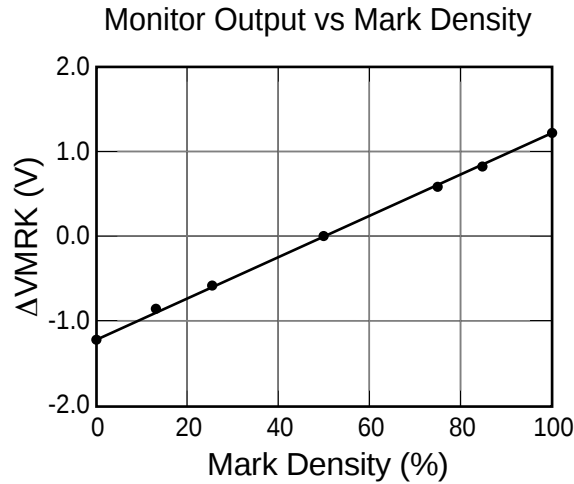
(3) Circuit Current

Conditions
 $V_{DD} = \text{GND}, V_{IN@D_{IN}} = -1.0V$
 $V_{IN@D_{INB}} = -1.3V, V_{MIN} = V_{SS}, V_{BIN} = V_{SS}$
 $V_{OUT@OUT}, OUT_B, OUT_{BIAS} = \text{GND}$

(4) Signal Input Resistor and Bias Monitor Resistor

Conditions
 $V_{DD} = \text{GND}, V_{SS} = -5V, V_{IN@D_{IN}} = -1.0V$
 $V_{IN@D_{INB}} = -1.3V, V_{MIN} = V_{SS}, V_{BIN} = V_{SS}$
 $V_{OUT@OUT}, OUT_B, OUT_{BIAS} = \text{GND}$
Conditions
 $V_{DD} = \text{GND}, V_{SS} = -5V, V_{IN@D_{IN}} = -1.0V$
 $V_{IN@D_{INB}} = -1.3V, V_{MIN} = V_{SS}, V_{BIN@I_B} = 60\text{ mA}$
 $V_{OUT@OUT}, OUT_B, OUT_{BIAS} = \text{GND}$

(5) Mark Density Monitor Voltage



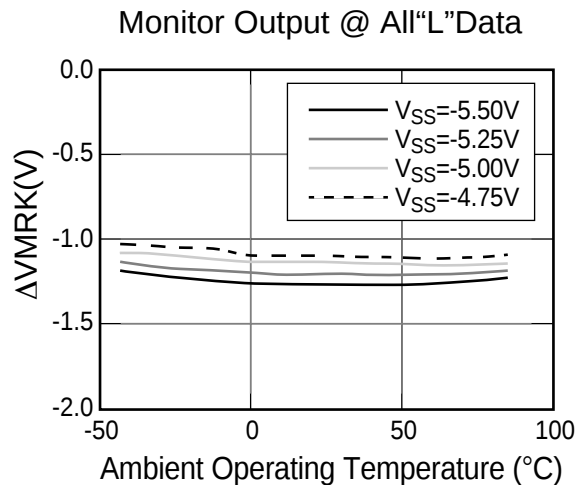
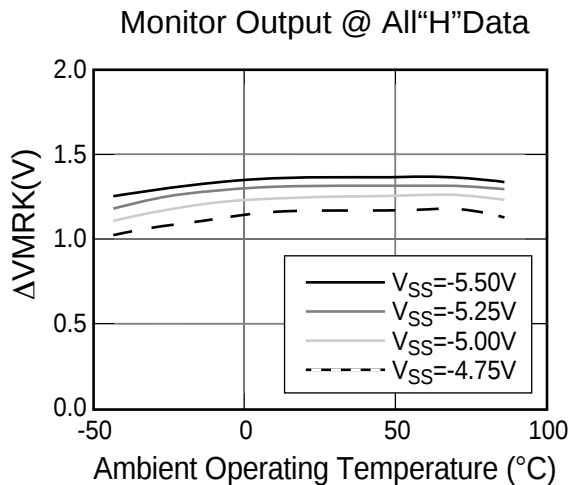
Conditions (See test circuits for AC characteristics)

$V_{DD}=GND$, $V_{SS}=-5\text{ V}$, @2.48832 Gb/s, PRBS2²³-1

$V_{IN}@D_{IN}$, D_{INB} , CK_{IN} , $CK_{INB}=-0.9\text{ V}/-1.7\text{ V}$

$V_{MIN}@I_{Mpeak}=60\text{ mA}$, $V_{BIN}=V_{SS}$

$V_{OUT}@OUT_{BIAS}=GND$, $T_a=25\text{ }^{\circ}\text{C}$



Conditions

$V_{DD}=GND$, $V_{IN}@D_{IN}=-1.0\text{ V}$, $V_{IN}@D_{INB}=-1.3\text{ V}$

$V_{MIN}@I_{Mpeak}=60\text{ mA}$, $V_{BIN}=V_{SS}$

$V_{OUT}@OUT$, OUT_B , $OUT_{BIAS}=GND$

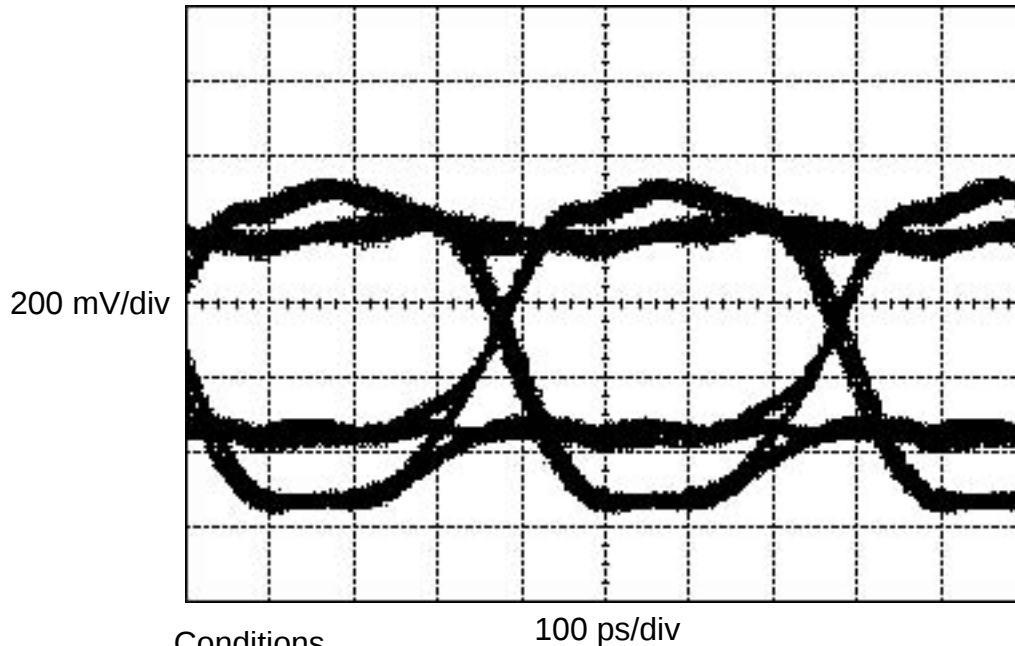
Conditions

$V_{DD}=GND$, $V_{IN}@D_{IN}=-1.6\text{ V}$, $V_{IN}@D_{INB}=-1.3\text{ V}$

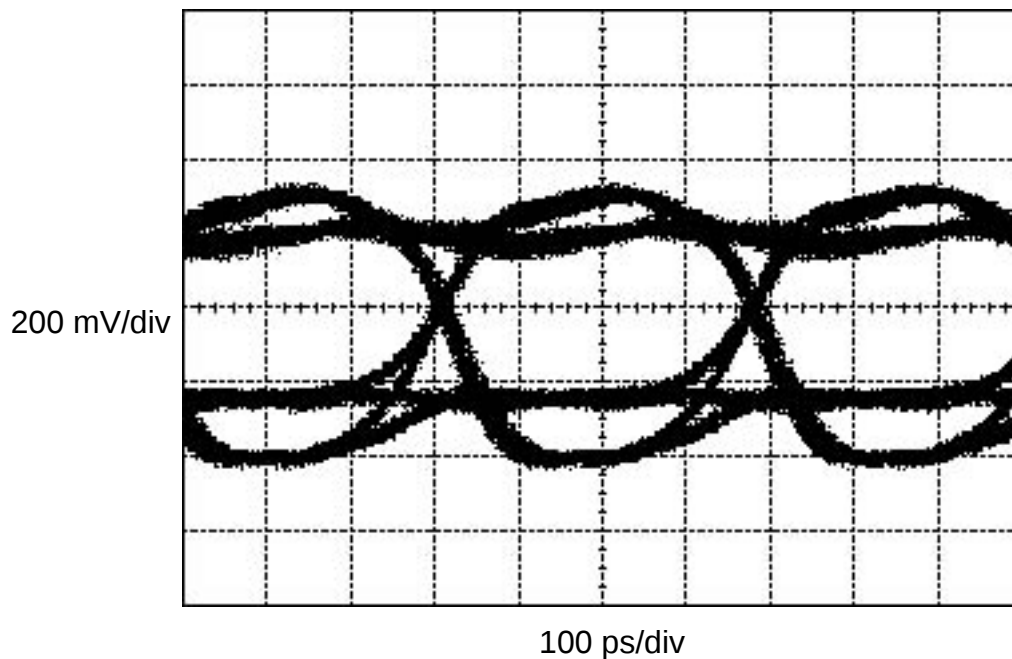
$V_{MIN}@I_{Mpeak}=60\text{ mA}$, $V_{BIN}=V_{SS}$

$V_{OUT}@OUT$, OUT_B , $OUT_{BIAS}=GND$

(6)-(a) Electrical Output Waveform @Clocked Operation

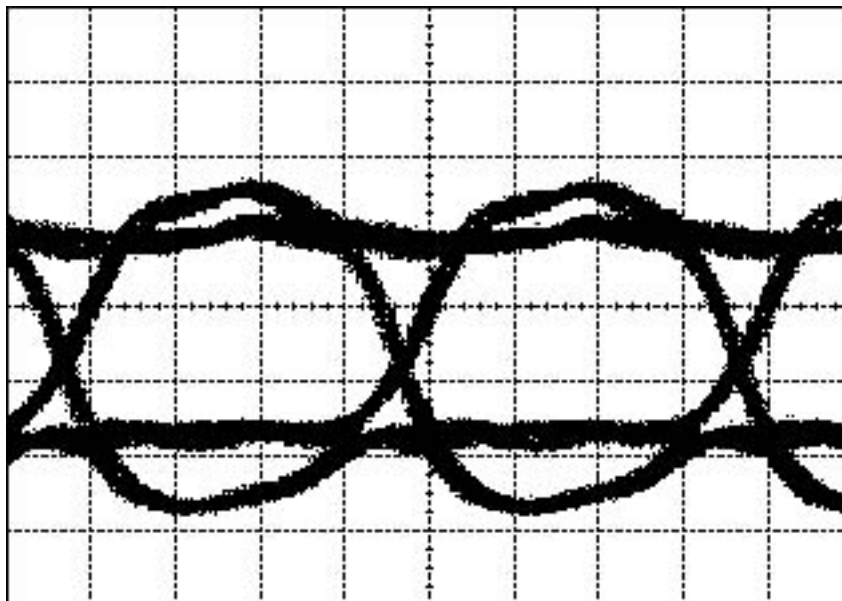
Conditions

$T_a = 25^\circ\text{C}$, $V_{DD} = \text{GND}$, $V_{SS} = -5\text{ V}$,
 D_{IN} : $V_{IL} = -1.7\text{ V}$, $V_{IH} = -0.9\text{ V}$, $D_{INB} = -1.3\text{ V}$, @2.5 Gb/s, PRBS2²³-1
 CK_{IN} : $V_{IL} = -1.7\text{ V}$, $V_{IH} = -0.9\text{ V}$, $CK_{INB} = -1.3\text{ V}$, $f = 2.5\text{ GHz}$
 $V_M = -3.9\text{ V}$, $V_B = -5.0\text{ V}$, $R_L = 15\text{ ohms}$

Conditions

$T_a = 25^\circ\text{C}$, $V_{DD} = \text{GND}$, $V_{SS} = -5\text{ V}$,
 D_{IN} : $V_{IL} = -1.7\text{ V}$, $V_{IH} = -0.9\text{ V}$, $D_{INB} = -1.3\text{ V}$, @2.5 Gb/s, PRBS2²³-1
 CK_{IN} : $V_{IL} = -1.7\text{ V}$, $V_{IH} = -0.9\text{ V}$, $CK_{INB} = -1.3\text{ V}$, $f = 2.7\text{ GHz}$
 $V_M = -3.9\text{ V}$, $V_B = -5.0\text{ V}$, $R_L = 15\text{ ohms}$

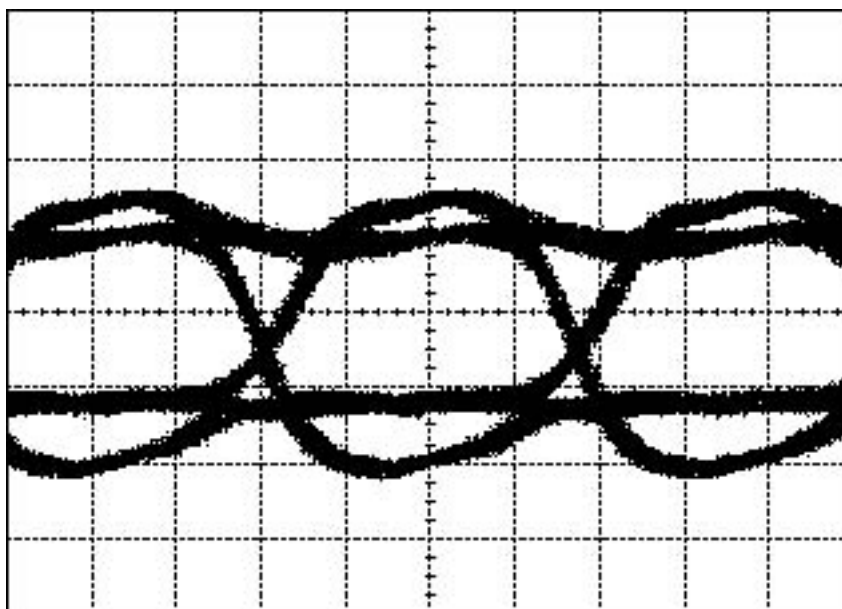
(6)-(b) Electrical Output Waveform @non-Clocked Operation

Conditions

$T_a = 25\text{ }^{\circ}\text{C}$, $V_{DD} = \text{GND}$, $V_{SS} = -5\text{ V}$,

D_{IN} : $V_{IL} = -1.7\text{ V}$, $V_{IH} = -0.9\text{ V}$, $D_{INB} = -1.3\text{ V}$, @2.5 Gb/s, PRBS2²³-1

$V_M = -3.9\text{ V}$, $V_B = -5.0\text{ V}$, $R_L = 15\text{ ohms}$

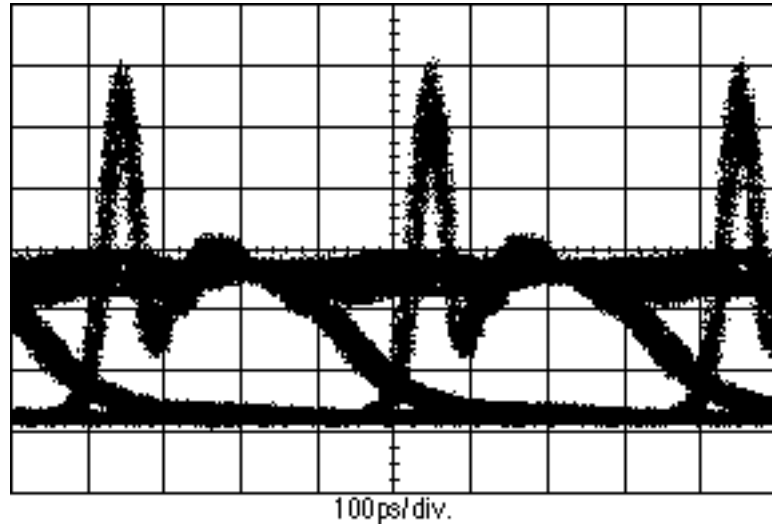
Conditions

$T_a = 25\text{ }^{\circ}\text{C}$, $V_{DD} = \text{GND}$, $V_{SS} = -5\text{ V}$,

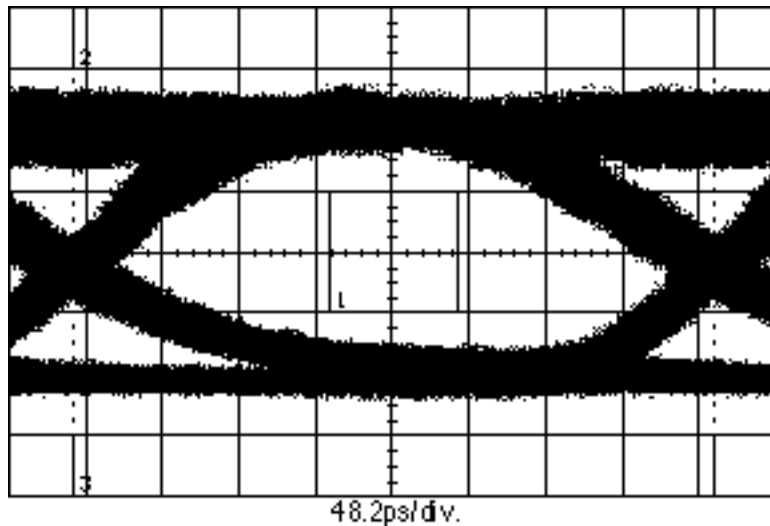
D_{IN} : $V_{IL} = -1.7\text{ V}$, $V_{IH} = -0.9\text{ V}$, $D_{INB} = -1.3\text{ V}$, @2.5 Gb/s, PRBS2²³-1

$V_M = -3.9\text{ V}$, $V_B = -5.0\text{ V}$, $R_L = 15\text{ ohms}$

(7)-(a) Optical Output Waveform @2.48832Gb/s (1310nm FP-LD)

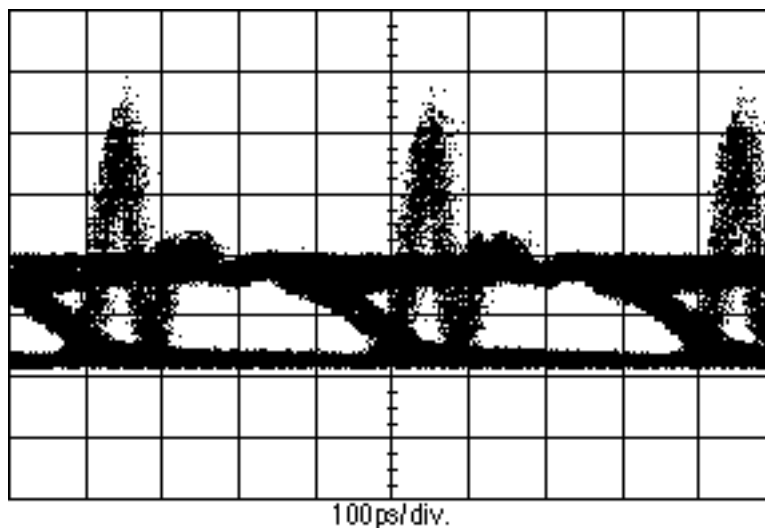
Conditions

$T_a = 25\text{ }^{\circ}\text{C}$, $V_{DD} = \text{GND}$, $V_{SS} = -5\text{ V}$, @2.48832 Gb/s, PRBS2²³-1
 $V_{IN@D_{IN}}$, D_{INB} , CK_{IN} , $CK_{INB} = 0.8\text{Vp-p}$ (AC coupled)

Conditions

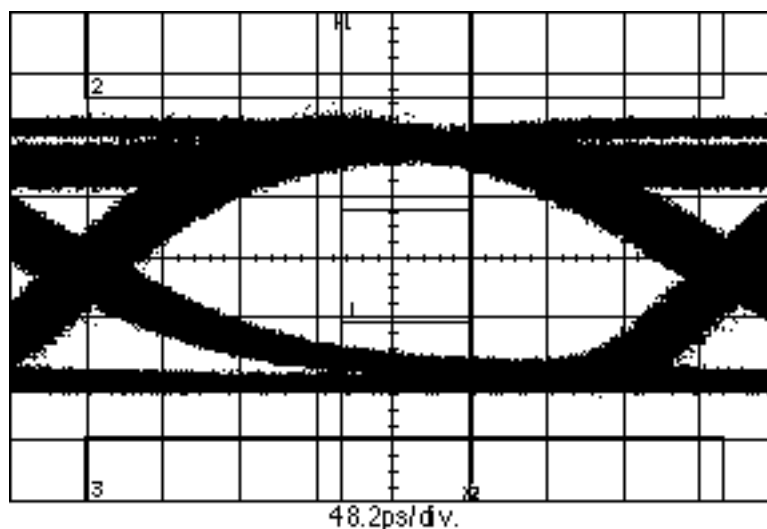
$T_a = 25\text{ }^{\circ}\text{C}$, $V_{DD} = \text{GND}$, $V_{SS} = -5\text{ V}$, @2.48832 Gb/s, PRBS2²³-1
 $V_{IN@D_{IN}}$, D_{INB} , CK_{IN} , $CK_{INB} = 0.8\text{Vp-p}$ (AC coupled)
 with fourth order Bessel-Thompson filter

(7)-(b) Optical Output Waveform @2.48832Gb/s (1310nm DFB-LD)

Conditions

$T_a = 25^\circ\text{C}$, $V_{DD} = \text{GND}$, $V_{SS} = -5\text{ V}$, @2.48832 Gb/s, PRBS2²³-1

$V_{IN@D_{IN}}$, D_{INB} , CK_{IN} , $CK_{INB} = 0.8\text{ Vp-p}$ (AC coupled)

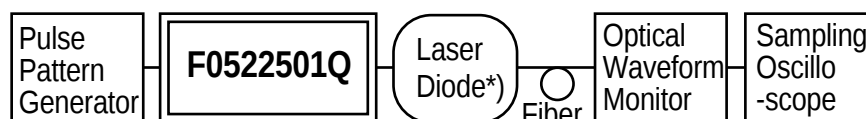
Conditions

$T_a = 25^\circ\text{C}$, $V_{DD} = \text{GND}$, $V_{SS} = -5\text{ V}$, @2.48832 Gb/s, PRBS2²³-1

$V_{IN@D_{IN}}$, D_{INB} , CK_{IN} , $CK_{INB} = 0.8\text{ Vp-p}$ (AC coupled)

with fourth order Bessel-Thompson filter

◆ Test Circuit

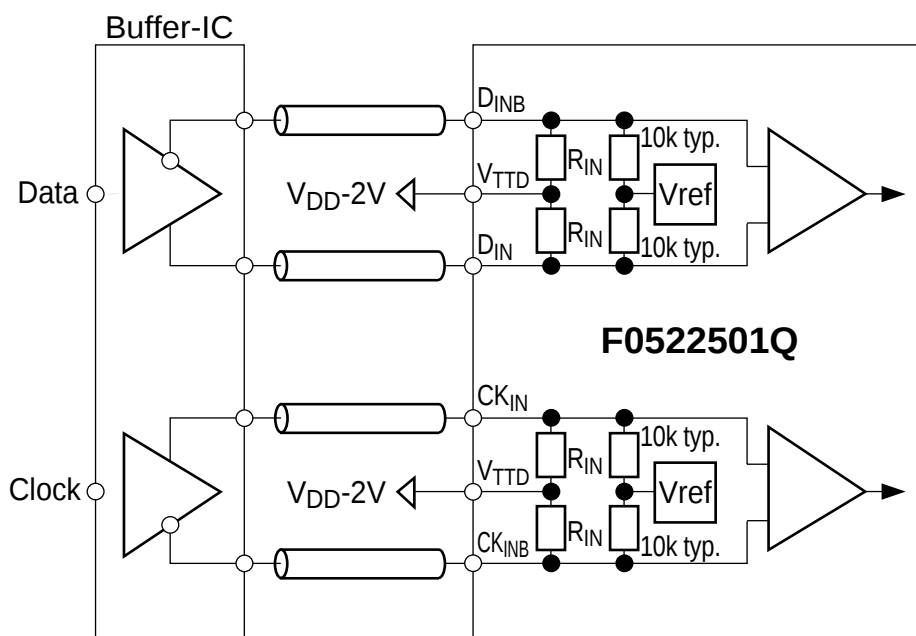


*) 1310nm DFB-LD:SLT4200Series (Sumitomo Electric Industries, LTD.)
 1310nm FP-LD:SLT4100Series (Sumitomo Electric Industries, LTD.)

◆ Application Guide

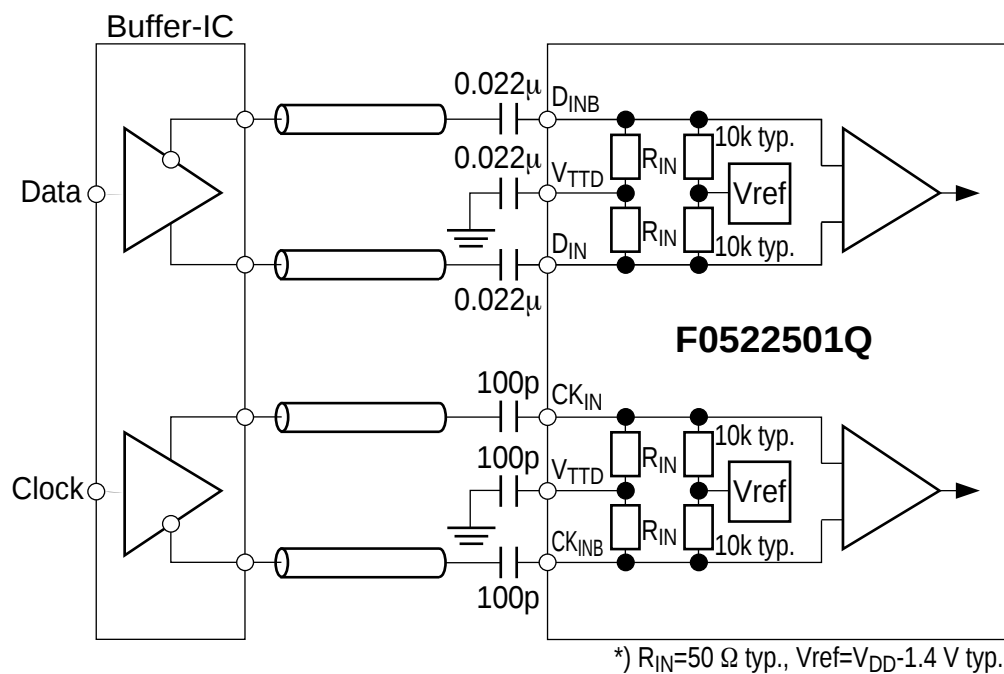
(1) Data and Clock Input Interface

(a) Differential ECL (or PECL) Interface

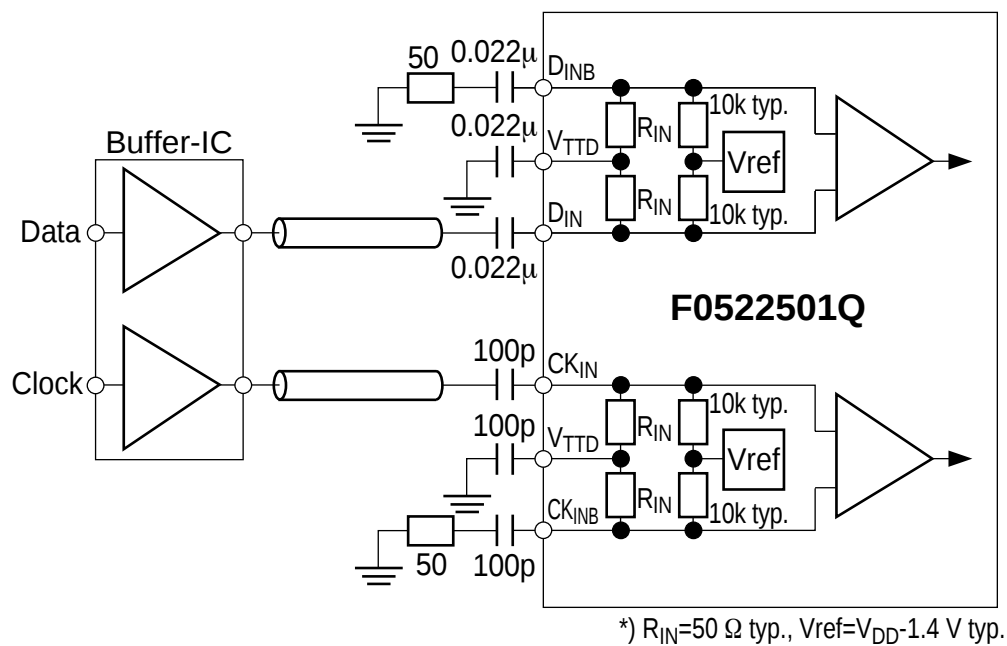


*) $R_{IN}=50\ \Omega$ typ., $V_{ref}=V_{DD}-1.4\ V$ typ.

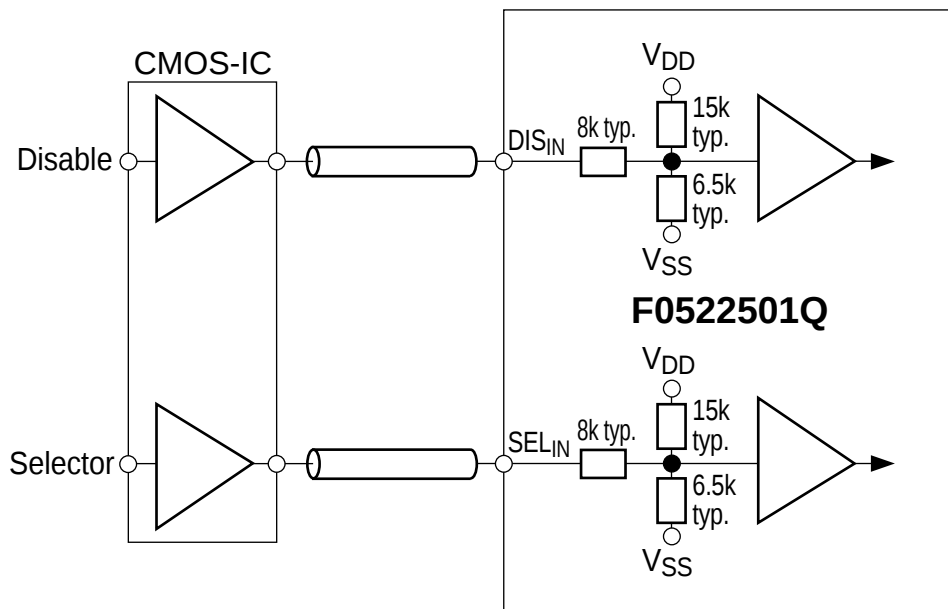
(b) Differential AC Coupled Interface



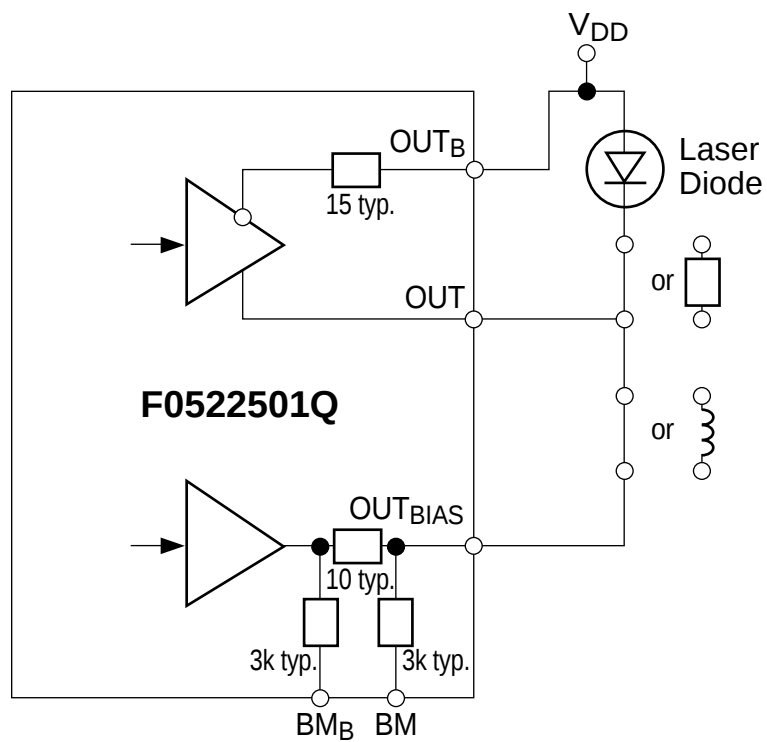
(c) Single-Ended AC Coupled Interface



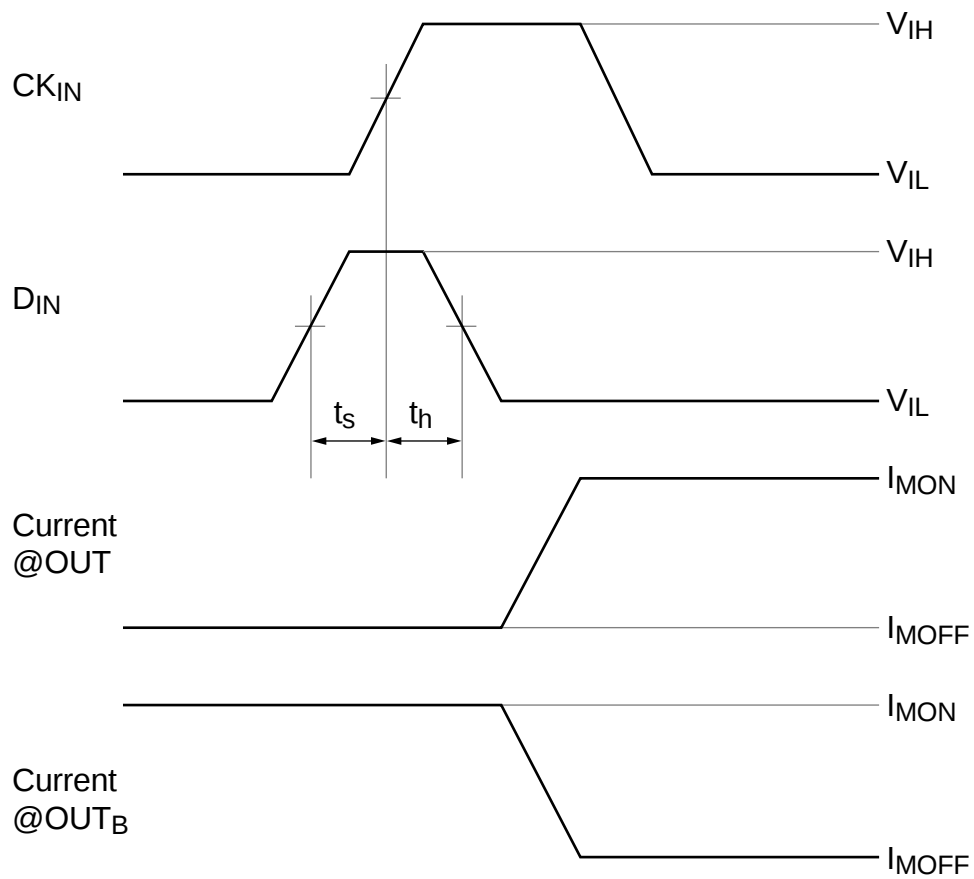
(2) Disable Input and Selector Input Interface



(3) Current Output Interface



(5) Timing Chart



Dimension: millimeters

◆ APC (Auto Power Control) Sample Circuit

