

APPLICATION NOTE

Fiber optic transceiver board STM1/4/8, OC3,12,24, FC/GE

AN98090

Abstract

This application note describes demoboard OM5802. This demoboard is designed for customer demonstration of Philips Semiconductors' TZA30xx series ICs. The functionality which can be demonstrated are: full receiver (TZA3030, TZA3000, TZA3040), Data and clock recovery (TZA3004), Transceiver (demultiplexer, frame detect & alignment, multiplexer and clock convertor, TZA3005) and Laserdriver (TZA3031, TZA3001, TZA3041). Since the pinout of the ICs is identical for 155, 622, 1062.5 and 1250 Mbps, the board can be used for all these datarates. Only the appropriate ICs must be chosen for the datarate.

The application note is limited to information not described in the individual datasheets.

Apart from a sample application of the ICs, a cleanup PLL, acting as reference generator in Add/Drop Multiplexers has been added to the board.

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APPLICATION NOTE

Fiber optic transceiver board STM1/4/8, OC3,12,24, FC/GE

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Keywords

Telecom
Optical networks
SDH
SONET
STM1, STM4, Fiber Channel, Gigabit Ethernet
OC3, OC12, OC24
CML, PECL
1 chip receiver
High transimpedance overload
Laser output control

Number of pages: 55

Date: 28 september 1998

**Fiber optic transceiver board STM1/4/8,
OC3,12,24, FC/GE****Application Note
AN98090****Introduction**

This application note is written to support the following ICs:

TABLE 1 Supported ICs for demoboard OM5802

Datarate [Mbps]	Functionality			
	1 chip receiver	Data & Clock recovery unit	Aligned Mux/Demux, Clock converter	Laserdriver
155	TZA3030	TZA3004	TZA3005	TZA3031
622	TZA3000	TZA3004	TZA3005	TZA3001
1063	TZA3040	OQ2541		TZA3041
1250	TZA3040	OQ2541		TZA3041

The apnote consists of the following sections:

- Getting started: containing block diagram, connection setup and test description.
- General section: acronyms, layout consideration and cross section of the PCB.
- User interface: description of the functionality of buses, pin arrays, LEDs and switches on the board.
- Schematics: the complete schematic diagram of the board.
- Layouts: an enlarged view of the layers of the board.
- Bill of materials: the component mounted on the board.

No detailed description of the blocks and measurements are available on this moment. They will be described in a document which will be available in October 1998.

This document has been adapted from the AN97065 which described the previous board release (PR47512). The board revision described in this document is PR47513.

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1. Getting started:

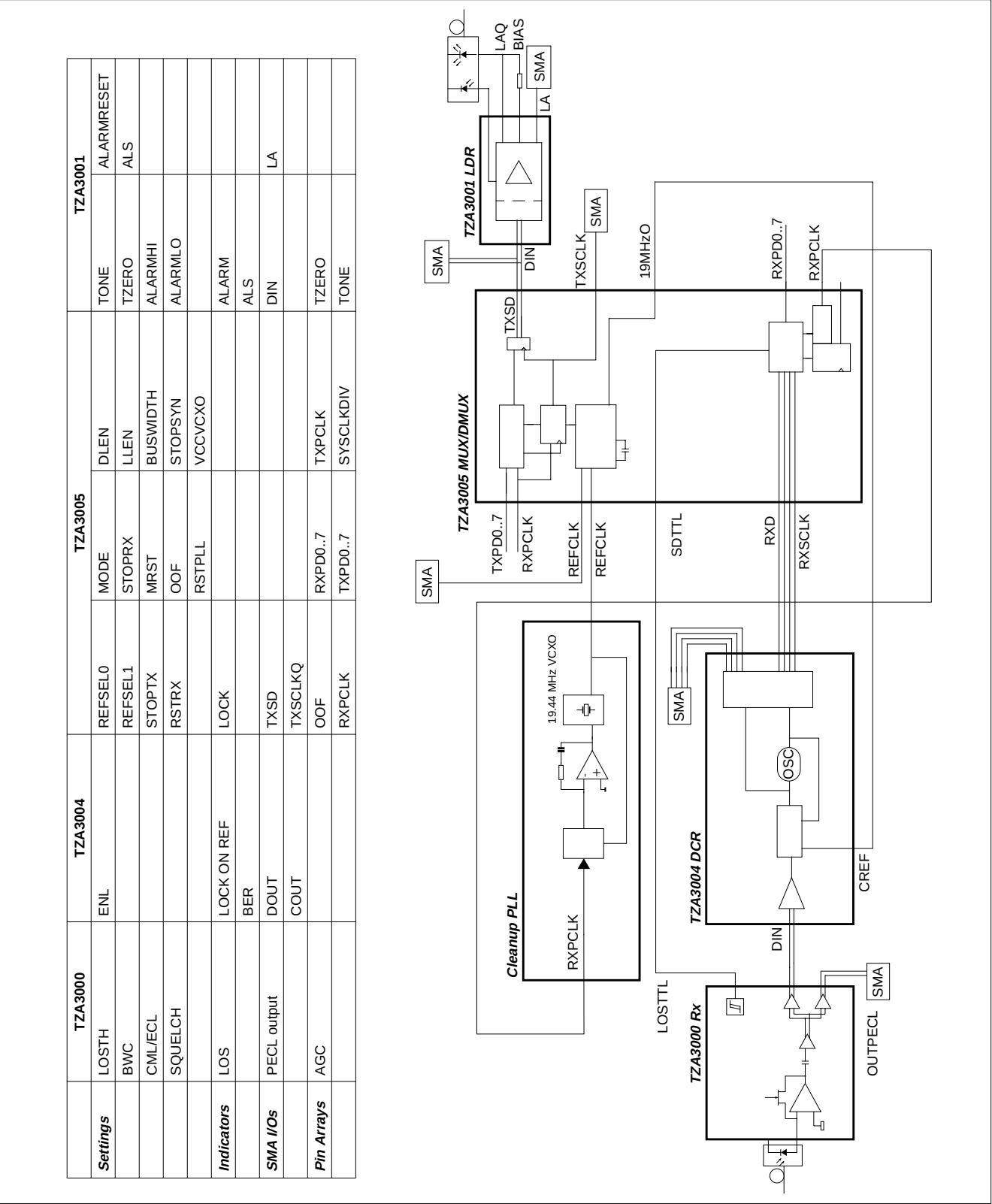


Fig.1 Block diagram of demoboard OM5802.

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1.1 Introduction

The demoboard OM5802 is designed to demonstrate the functionality of the following ICs:

TABLE 2 Supported ICs for demoboard OM5802

Datarate [Mbps]	Functionality			
	1 chip receiver	Data & Clock recovery unit	Aligned Mux/Demux, Clock converter	Laserdriver
155	TZA3030	TZA3004	TZA3005	TZA3031
622	TZA3000	TZA3004	TZA3005	TZA3001
1250	TZA3040	OQ2541		TZA3041

In this report, the 622 Mbps ICs will be used. All discussions are valid for the ICs of the different types.

In this section an overview of the board will be given. After this, some measurements will be shown.

1.2 Demoboard description

The receiver section of the board consists of the photodetector, transimpedance amplifier, lowpass filter and limiter (TZA3000), the data and clock recovery unit (TZA3004) and the demultiplexer (1/2 TZA3005).

The transmitter section consists of the cleanup PLL, the multiplexer and clock convertor (other half of TZA3005), the laserdriver (TZA3001) and the laserdiode.

For phase alignment & jitter filtering, a cleanup phase locked loop has been added (74HCT9046+19.44 MHz VCXO).

1.3 Test possibilities

1.3.1 1 chip receiver TZA3000

The TZA3000 has 2 outputs (CML and PECL levels). The PECL level outputs are available at SMA connectors. This gives the user the possibility to test the TZA3000 separate from the rest of the system.

1.3.2 Data and clock recovery unit TZA3004

The TZA3004 has 2 outputs (Normal and Loop). The Normal data and clock outputs are available at SMA connectors. This gives the user the possibility to test the TZA3000 and the TZA3004 combination separate from the rest of the system. The Loop outputs are connected with the Demux.

If the TZA3005 is not on the board (in case of the 1250 Mbps configurations), the reference clock for the DCR needs to be provided via REFCLKQ.

1.3.3 Mux/Demux TZA3005

The TZA3005 receiver tests have to be done in conjunction with the TZA3000 and TZA3004. The board does not contain a separate serial input.

The parallel clock, data and frame outputs are available on pin arrays to connect to a logic analyzer. The frame alignment enabling is also available to the user. A buffered version of the parallel clock and a copy of the frame pulse are available on SMB connectors

The TZA3005 transmitter part can be tested apart from the system: the serial data is available on the LDR DIN / LDR DINQ SMA connectors. The serial clock is attenuated and connected with an SMA connector.

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The parallel input data can be supplied to the pin array (TXPD0..7).

SMB connectors carry the signals SYCLKDIV and TXPCLK.

1.3.4 Laserdriver TZA3001

The laserdriver gets its data signals from the summed outputs of the SMA connectors (LDR DIN/DINQ) and the serial multiplexer data (TXSD/TXSDQ). Testing the laserdriver separate from the TZA3005 is possible if the output of the multiplexer is stopped (STOPTX). Signals should be connected to the SMA connectors (LDR DIN/DINQ).

The output of the laserdriver is a differential pair (LA/LAQ). One output drives the Laser (LAQ), the other drives a dummy load. An attenuated version of this dummy voltage is connected with an SMA connector (LA).

1.4 How to test & what to set

1.4.1 Introduction

In this section mounting of the photodetector and laserdiode is described. After this a limited number of tests are shown, in combination with the switch setting. Detailed description of the tests can be found in individual sections.

1.4.2 Mounting of the photodetector

This is done by mounting resistor R105. When a board passes this test, the resistor is removed

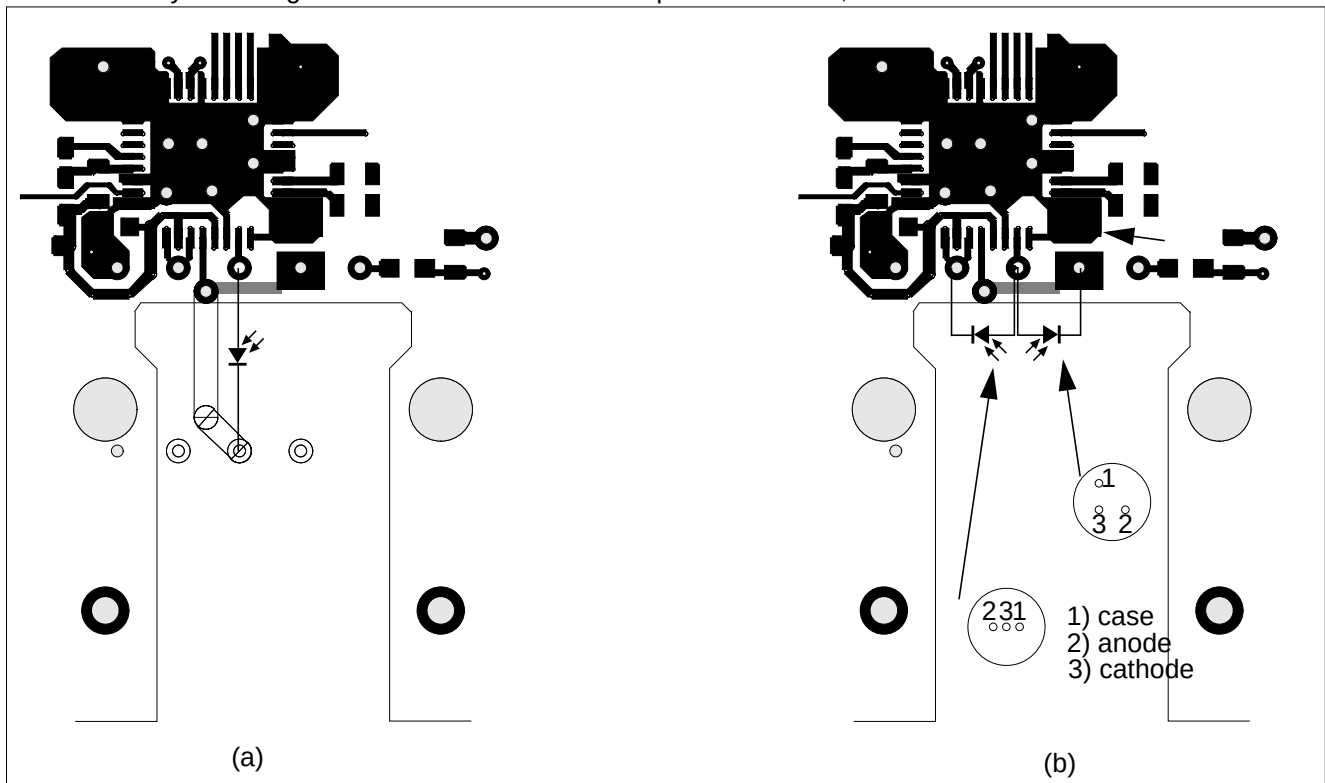


Fig.2 Enlargement of the receiver section. The top layer is shown in top view. When a (mini)DIL packaged detector is used, holes are foreseen for the package (a). The PCB has standard a cutout for a coaxial type detector (b). Two types of coax packages are foreseen. The pinning of these packages is shown in bottom view.

1.4.3 Mounting of the laserdiode

Standard, the board is tested electrically. The bias & modulation source are then terminated to VCC with a dummy load. After test pass, these resistors are removed.

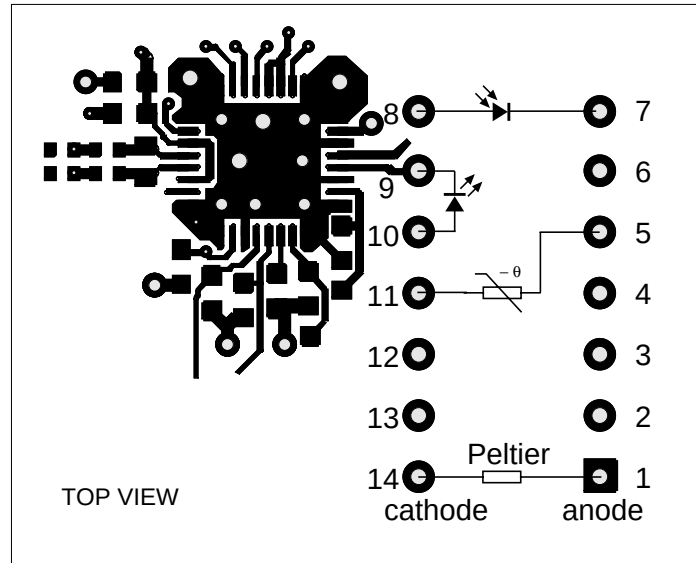


Fig.3 Enlargement of the transmitter section. The top layer is shown in top view. The picture shows the footprint of the used laser with corresponding pin-functionality.

1.4.4 Supply voltages

Standard, the board is tested on 5.0 V supply voltages. The supply voltages selectors on the bottom side of the PCB are set to this.

If other voltages are required, please follow the description in section 3.3.

1.4.5 Back to back sensitivity measurement: Laserdriver in - DCR out

In this measurements 2 aspects have to be taken into account:

- Polarity inversion in the path from SMA connectors to light output

The SMA connectors LDR DIN / LDR DINQ are connected via a resistive splitter to the outputs of the multiplexer (TXDQ / TXSD) and the inputs of the laserdriver (DIN/DINQ). When the multiplexer is turned off, the signal on the connector drives the corresponding laserdriver inputs (LDR DIN - DIN and LDR DINQ - DINQ).

Note that the “Q” output of the multiplexer is connected to the “normal” input of the laserdriver. The laserdriver inverts the output of the multiplexer!

To correct for this, the LAQ output is connected to the laser, and the LA output can be monitored at the SMA connector LA.

IF A PATTERN GENERATOR OUTPUT IS CONNECTED WITH THE ‘LDR DIN/LDR DINQ’ INPUTS, A SIGNAL INVERSION OCCURS. THIS SHOULD BE TAKEN INTO ACCOUNT WHEN PERFORMING A BIT ERROR TEST.
- Turning off the output of the multiplexer & keeping the 19 MHz from the synthesizer

The test signal STOPTH from the multiplexer TZA3005 turns both the output stages and the synthesizers

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off.

This is a problem since the TZA3004 needs the 19 MHz signal, generated by the TZA3005's synthesizer. Therefore remove C307 and C308, and mount a dummy load of 100 ohm between the outputs of the transmission lines from the splitter.

This ensures proper termination & pulse waveform at the laserdriver, and the TZA3005 can remain on to generate the 19 MHz for the TZA3004, without disturbing the input signal of the TZA3001 laserdriver.

3. Providing a 19 MHz reference for the DCR directly via REFCLKQ
A provision has been made to provide a reference clock without the TZA3005. This is enabled by removing 0 ohm resistor R511 and connecting a 220 nF 1206 capacitor on pads for C519 (diagonally on the PCB near L306. This provides a path to the net '19MHz3004'.

The following measurement equipment is necessary for this measurement

1. Pattern generator. Output level 400 .. 800 mV.
2. Optical attenuator
3. Optical power meter
4. Bit Error Receiver
5. Power supply of 3.3 V and 5.0 V max 800 mA for the demoboard

The connections of the measurement equipment to the board should be done as follows:

1. Connect 3.3 V and 5.0 V power supply to the demoboard
2. Connect the output of the laser to the optical attenuator input
3. Connect the electrical output LA to a sample scope. This shows the switching current of the laser
4. Connect the output of the optical attenuator to the photo detector input
5. Either remove C307 and C308 & place a dummy OR apply a clock via REFCLKQ and make the connection via the C519 (both described above).
6. Connect the output of the pattern generator to LDR DIN and LDR DINQ. If a single ended source is used, terminate the non-used input with 50 ohm.
7. Connect the Bit Error Receiver to the COUT/COUTQ and DOUT/DOUTQ outputs of the Data & Clock recovery unit. If a single ended receiver is used, terminate the non-used outputs with 50 ohm.
8. Mind the polarity inversion of the total system. (Use signal inversion on the Bit Error Receiver).
9. Disable the TZA3001 alarms by either changing the alarm levels (Potentiometer Alarmhi/Alarmlo) or setting 'AlarmReset' high.
10. Set the TZA3000 output to DCR by selecting CML: CML/ECL = high
11. Set the Data & Clock recovery unit in 'both' mode by making ENL = LOW
12. Check if the reference frequency for the DCR is available. If the TZA3005 Mux/demux generates 19 MHz for the DCR by activating it: all other switches should be low, except MODE=HIGH, DLEN=HIGH and LLEN=HIGH. If the REFCLKQ input is used: check the connection.

1.4.6 Sensitivity on 1 chip receiver TZA3000

When the TZA3000 is solely tested, the PECL outputs should be selected. (PECL/CML = LOW).

1.4.7 Laserdriver output waveforms

The setup of the transmitter is identical to that of the sections above. The optical output can be monitored on an optical oscilloscope.

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The receiver TZA3000 is not used in case.

1.5 Switches setting overview for 622 Mbps mode

TABLE 3 Switches settings for OM5802/PR47513 Tests described in this section. 'H' means high, LED on. 'L' means low, LED off. 'X' is don't care.

Block	Name	Laserdriver to Receiver TZA3000 TZA3001 TZA3004	Laserdriver to Receiver TZA3000 TZA3001	Optical Waveform TZA3001
TZA3000	Squelch	L	L	L
	PECL_CML	H	L	H
	LOSTTL (LED)	X	X	X
TZA3004	ENL	L	L	H
	OOL3004 (LED)	L	L	L
	SIG3004 (LED)	H	H	H
TZA3005	BUSWIDTH	L	L	L
	OOF	L	L	L
	LLEN	H	H	H
	DLEN	H	H	H
	MODE	H	H	H
	STOPRX	L	L	L
	MRST	L	L	L
	RSTRX	L	L	L
	STOPOSYN	L	L	L
	STOPTX	L	L	L
	R1 (REFSEL1)	L	L	L
	R0 (REFSEL0)	L	L	L
	LOCKDET (LED)	H	H	H
Cleanup PLL	RST_PLL	L	L	L
	VCCVCXO	H	H	H
TZA3001	ALS	L	L	L
	ALARM3001 (LED)	L	L	L
	ALS_ON (LED)	L	L	L
	AlarmReset	L	L	L

1.6 Results: BER and Laser output waveform

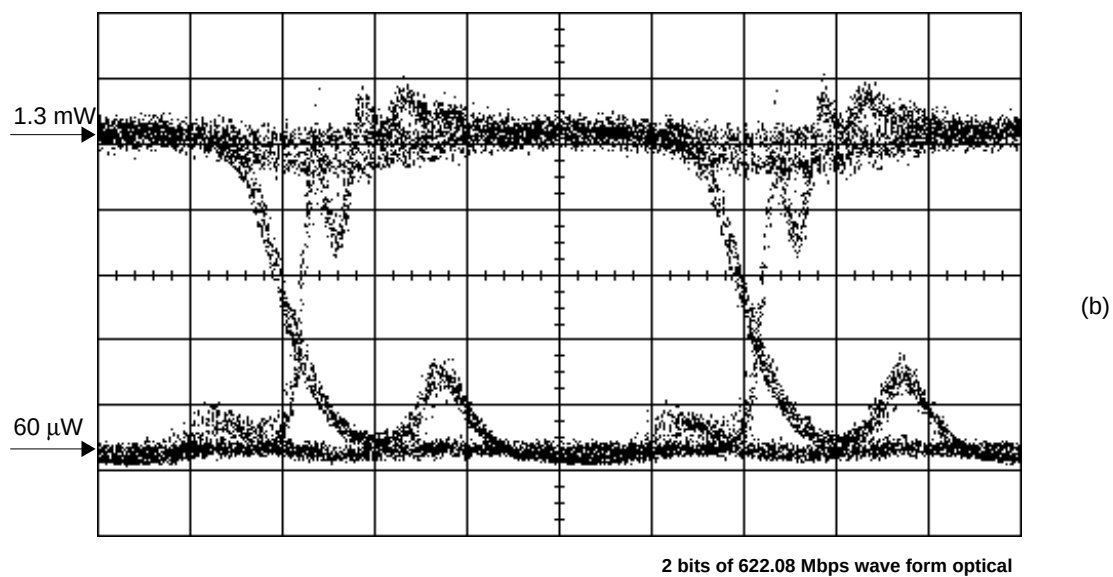
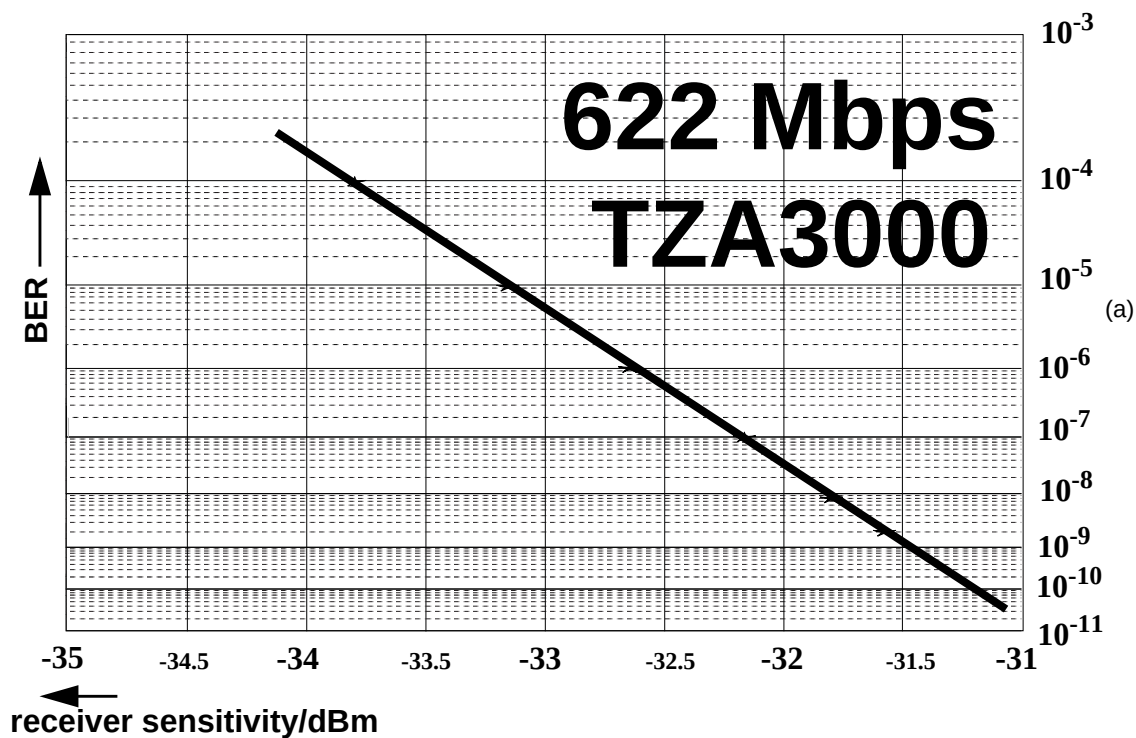


Fig.4 Results of sensitivity measurement (a) and laser unfiltered optical eye (b)..
These plots were the results of the measurements described in this section.

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2. GENERAL

2.1 Acronyms

- 155 155.52
- 622 622.06
- 1063 1062.5
- TZA Type number indication
- PCB Printed Circuit Board
- GND Ground
- IC Integrated Circuit
- W Width
- Cu Copper
- DIL Dual in Line
- ITU International Telecommunication Union
- DCR Data and Clock Recovery (unit)
- DMUX Demultiplexer (deserializer, from serial data to parallel data)
- MUX Multiplexer (serializer, from parallel data to serial data)
- N Integer
- OOF Out of Frame
- REFSEL0 Reference frequency setting, input #0
- REFSEL1 Reference frequency setting, input #1
- DLEN Data Loopback Enable
- LLEN Line Loopback Enable
- MRST Master Reset
- STOPTH Stop Transmitter
- RST_PLL Reset PLL
- VCCVCXO Power supply of VCXO
- VCXO Voltage Controlled Crystal Oscillator
- RST_ALARM Reset alarm
- ENL Enable Loop
- BWC Bandwidth Control
- SMA RF connector 50 ohm system impedance
- SMB Small outline DC connectors
- Pxxx Identification label for Pins, buses and connectors
- ..Q indication for inverted signal

2.2 Layout considerations

The layout for the demoboard is designed on a 4 layer PCB. The layers are numbered: top layer 1, bottom layer 2, buried layer top 3 and buried layer bottom 4. The copper on the layers is 35 μm thick, the space between the layers is 0.435 and 0.5 mm. The material is FR4, with relative dielectric constant $\epsilon_r=4.3$. No buried via's are used. The use of the layers is ordered as follows (from top to bottom)

Layer 1, top: Signal

Layer 3, buried top: Global GND, except at TZA3005, where it carries the TTL lines

Layer 4, buried bottom: Global GND

Layer 2, bottom: Signal.

A global GND is used, mostly at layer 3 and 4

Under all high speed ICs the GND layers are connected with multiple as-large-as-possible vias, to reduce parasitic inductance between the GND planes.

The supply lines of the board are configured as star from connector to ICs/blocks.

The decoupling of all ICs/blocks is done with a two stage pi network: from the connector an individual line goes to the first pi network near the IC/block. Then all the voltage domains are individually decoupled by a pi filter. This filter is placed near the voltage domain pin. The last capacitor is placed as close as possible to the IC/block.

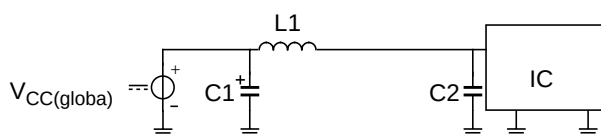
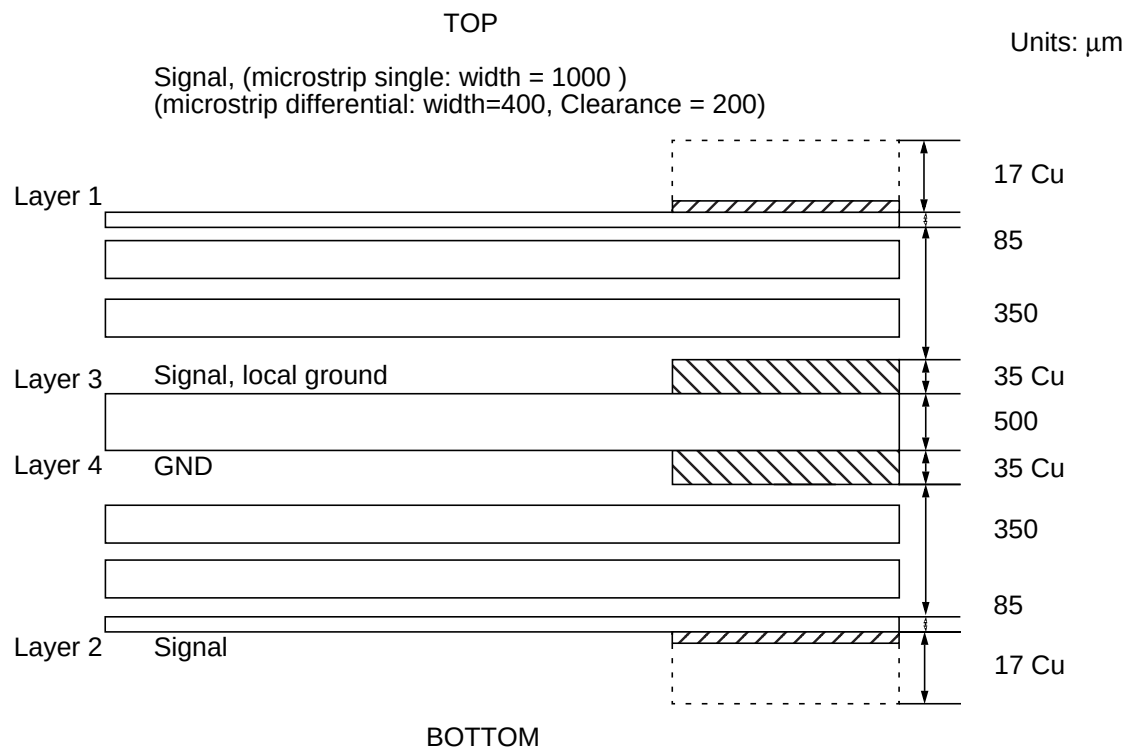


Fig.5 General setup of power supply decoupling network: From the global domain a pi filter provides the voltage for the local voltage domains. Capacitor C2 is placed as close as possible to the IC to reduce parasitic inductance.

Cross section of multilayer PCB



2.3 Optical components

The board has been made adaptable for DIL and coax types optical components.

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3. User Interface

3.1 SMA, SMB connectors and Arrays

TABLE 4 Pin Array usage

ID	Type	Name	Description
P106	ARRAY 1x2	AGC	AGC I/O, can be used for monitoring or controlling TZA300 AGC setting
P302	ARRAY 1x2	OOF	Out of frame input, can be used for connecting frame/deframer to board. Note that the board switch must be open. Disconnecting board signal can be done by removing R300
P405	ARRAY 1x2	One level	One level indicator of TZA3001 dual control loop, buffered voltage output
P406	ARRAY 1x2	Zero level	Zero level indicator of TZA3001 dual control loop, buffered voltage output
P300	ARRAY 2x10	RXPDP...	Receive parallel data outputs + frame pulse + clock output
P305	ARRAY 2x10	TXPD...	Transmit parallel data inputs + parallel clock input + system clock output

TABLE 5 Bus usage

ID	Type	Name	Description
P100	Bus 1x2	-	Test bus
P105	Bus 1x2	-	Test bus
P204	Bus 1x2	-	Test bus
P404	Bus 1x2	-	Test bus
P404	Bus 1x2	-	Test bus
P1	Stoko 3	-	Power supply connection
P2	Bus 1x3	-	Test bus
P304	Bus 1x1	-	VCC for fixed word probe
P306	Bus 1x1	-	VCC for fixed word probe
P310	Bus 1x5	-	Test bus
P312	Bus 1x4	-	Test bus
P313	Bus 1x4	-	Test bus
P404	Bus 1x2	-	Test bus
P407	Bus 1x2	-	Test bus

TABLE 6 SMA connector usage

ID	Type	Name	Description
P103	SMA edge	OUTPECL	PECL output of TZA3000, noninverted, AC coupled, active in 'ECL' mode
P107	SMA edge	OUTQPECL	PECL output of TZA3000, inverted, AC coupled, active in 'ECL' mode
P200	SMA edge	COUTQ	Clock output of TZA3004, inverted, AC coupled, active in 'normal' mode
P201	SMA edge	COUT	Clock output of TZA3004, non inverted, AC coupled, active in 'normal' mode
P202	SMA edge	DOUTQ	Data output of TZA3004, inverted, AC coupled, active in 'normal' mode

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ID	Type	Name	Description
P203	SMA edge	DOUT	Data output of TZA3004, non inverted, AC coupled, active in 'normal' mode
P309	SMA edge	REFCLKQ	Reference clock for TZA3005 clock converter, inverting input
P400	SMA edge	LDR DIN	Data input of TZA3001, non inverted, AC coupled
P402	SMA edge	LDR DINQ	Data input of TZA3001, inverted, AC coupled
P403	SMA edge	LA	Attenuated complementatry laser output of TZA3001

TABLE 7 SMB connector usage

ID	Type	Name	Description
P101	SMB straight	EL_IN	Test input for board test
P301	SMB square	RXCLK	Receive parallel clock, clock of parallel outgoing data of TZA3005
P303	SMB square	FP	Frame pulse, pulsed output of frame detect circuit of TZA3005
P307	SMB square	TXPCLK	Transmit parallel clock, incoming parallel clock of TZA3005
P308	SMB square	SYSCCLKDIV	Divided system clock, derived from TXSCLKQ
P311	SMB straight	TXSCLKQ	Output clock of TZA3005, has same jitter as output data

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3.2 Dipswitches & LEDs

TABLE 8 Dipswitches & LEDs

Block	LED	Switch	Name	Description
TZA30x0 1 chip receiver	D100	J100	Squelch	Enables squelch mode On=Active, Off=nonactive
	D101	J101	PECL/CML	Selection of output. On=CML, Off=PECL
	D102		LOS	LOSTTL flag. On=LOS of Signal
TZA3004 Data and clock recovery unit	D200		SIG3004	Inverted LOS indicator. On=Signal, Off=LOS
	D201	J200	ENL	Enables 'Loop' mode. On='Loop' mode, Off='Both' mode
	D202		OOL3004	Out Of Lock. Lock on 19 MHz when Frequency Window Detector of TZA3004 is active. On=within 1000 ppm of frequency window, Off=without 1000 ppm frequency window
TZA3005 Multiplexer Frame detect Demux Clock convertor	D300		LOCKDET	Lock of TZA3005' synthesizer on reference clock input
	D312	J312	STOPSYN	Test input: synthesizer section power down
	D301	J301	STOPTX	Test input : transmit section power down
	D302	J302	LLEN	Line loopback enable input (active LOW). On = no loopback (= normal operation), Off = loopback (serial output equals serial input)
	D303	J303	DLEN	Diagnostic loopback enable input (active LOW). On = no loopback (= normal operation), Off = loopback (parallel output equals parallel input)
	D304	J304	OOF	Out of frame enable input
	D305	J305	REFSEL0	Reference clock select input 0. With standard 19.44 MHz this should be set off
	D306	J306	REFSEL1	Reference clock select input 1. With standard 19.44 MHz VCXO this should be set off
	D307	J307	BUSWIDTH	4/8 bit bus width select input.
	D308	J308	MODE	Serial data rate select STM1/STM4
	D309	J309	RST_PLL	Reset clean up PLL
	D310	J310	RSTRX	test input : reset receive logic
	D311	J311	STOPRX	test input : transmit section powerdown
	D313	S300	MRST	master reset
TZA3001 Laserdriver	D400		ALARM3001	Bias alarm flag. On = Alarm, Off= No Alarm.
	D401	J400	ALS	Automatic Laser Shutdown
	D402	S400	Alarm Reset	Resets latch of Alarm3001 to ALS connection. On = Reset, Off = No Reset
	D403		ALS_on	Latched ALS active
	D503	J500	VCCVCXO	Supply of VCXO in cleanup PLL. Disable when external reference frequency is used

3.3 Supply voltage selectors

The supply voltage of the RF ICs can be either 5.0 +/- 5% or 3.3 +/- 5% V. The selection on the board is done by means of soldering the appropriate side of a copper trace selector. No switches are used, to prevent this switching from disturbing the operation. Note that ALL supplies must be set according to the table below: If the

**Fiber optic transceiver board STM1/4/8,
OC3,12,24, FC/GE****Application Note
AN98090**

TZA30x0 is set to 3.3 V, also the Data & Clock recovery unit should be set to 3.3 V and the Mux/Demux TZA3005 also. Note that J202 should be set to VCC-3.3 V. The transmitter cannot be changed, and is fixed to 5.0 V.

A star () indicates the 3.3 V side of all connectors..*

TABLE 9 Supply voltage of RF ICs

Typenr	Function	3.3V	5V	Jumper IC
TZA30x0	1 chip receiver	x	x	J102 and J103
TZA30x1	1 chip transmitter		x	
TZA3004	Data & Clock recovery unit	x	x	J201 and J202
TZA3005	Mux/Demux	x	x	J300

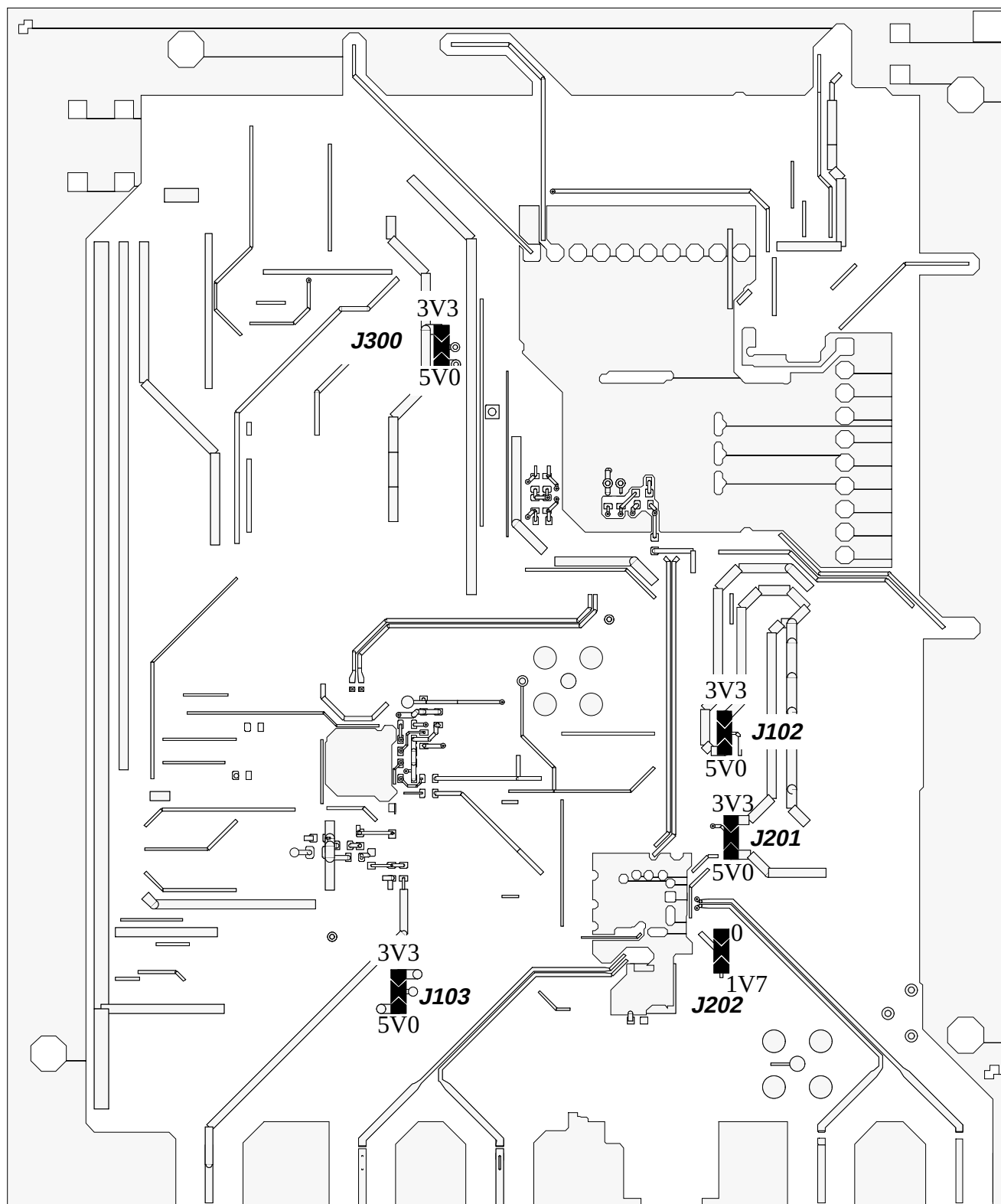
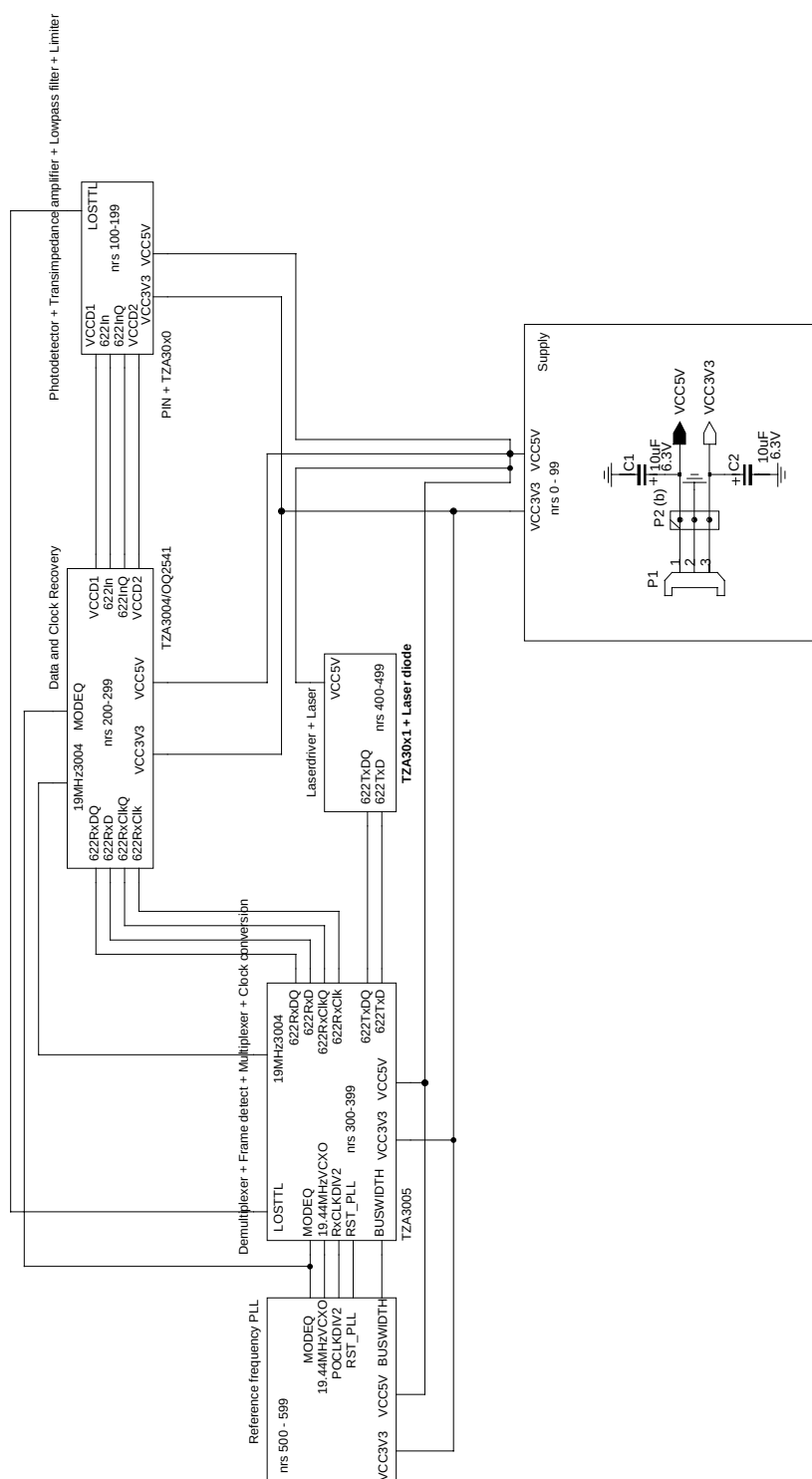
**Fiber optic transceiver board STM1/4/8,
OC3,12,24, FC/GE****Application Note
AN98090**

Fig.6 Voltage selection jumpers shown with selectable voltages. Note that all jumpers should have identical voltage and that J202 should be selected to VCC-3.3 V

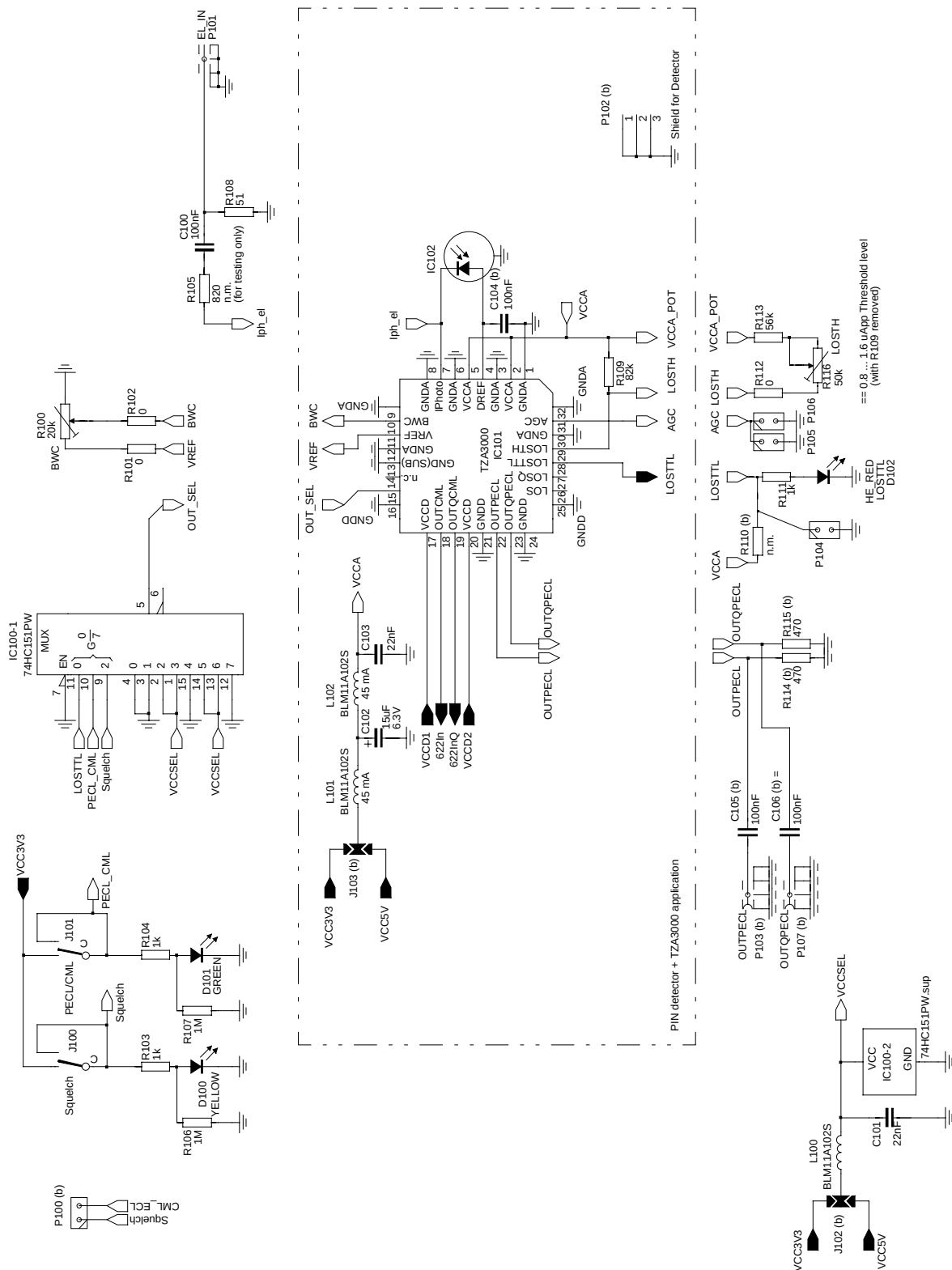
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4. Schematics

4.1 Overview

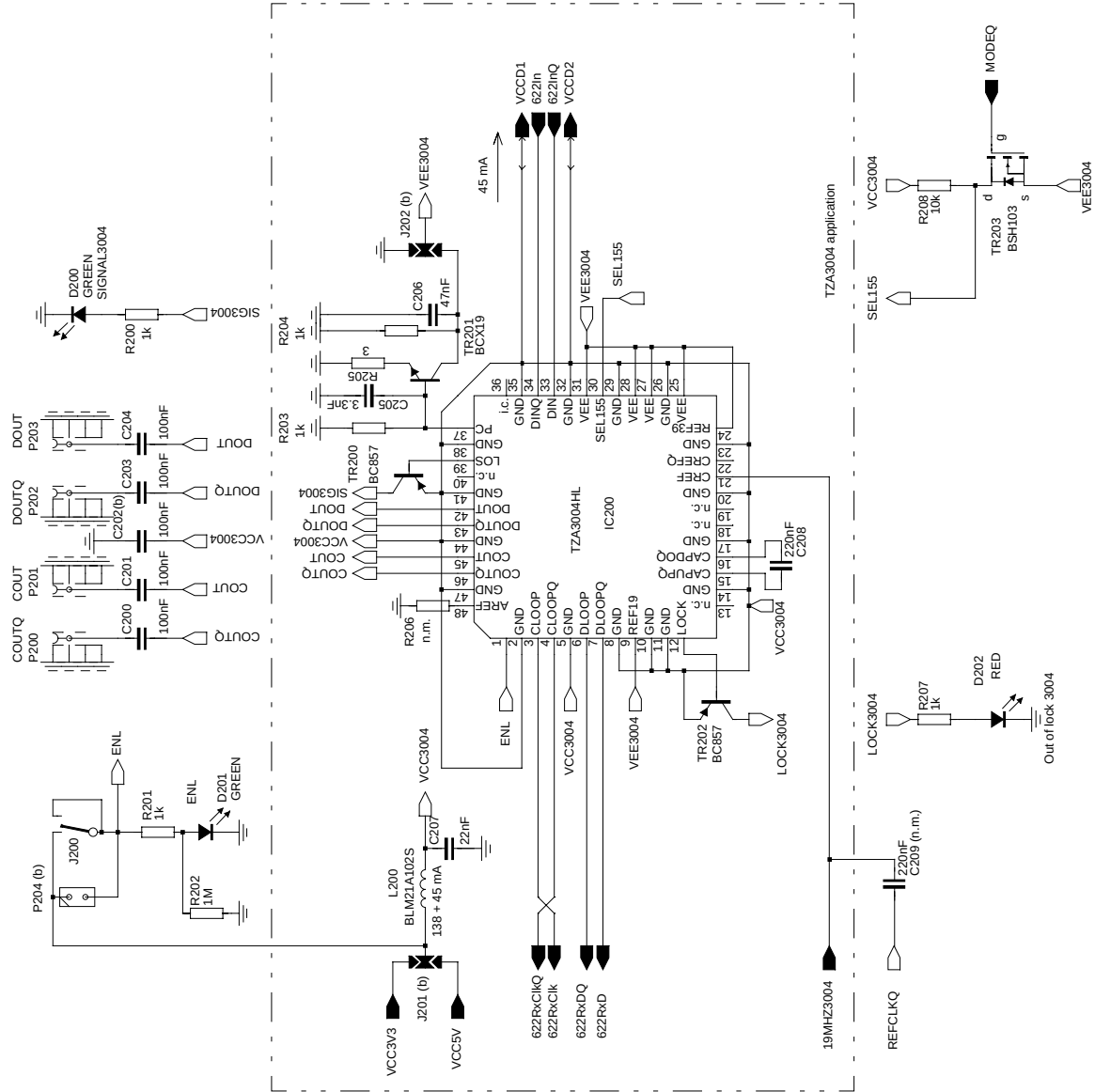


4.2



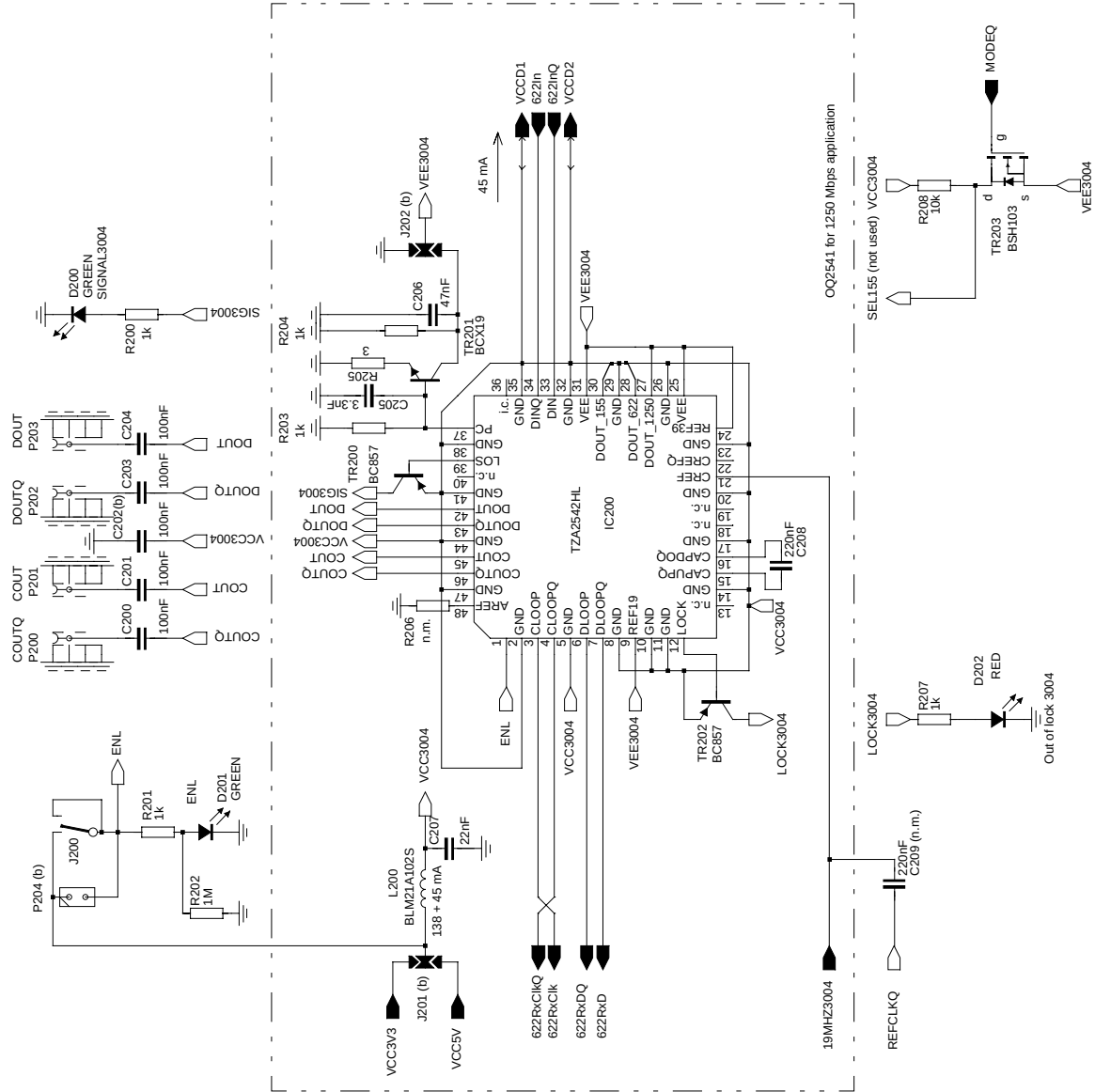
n.m. = not mounted
(b) = bottom placement

4.3 Data and Clock recovery device TZA3004: DCR



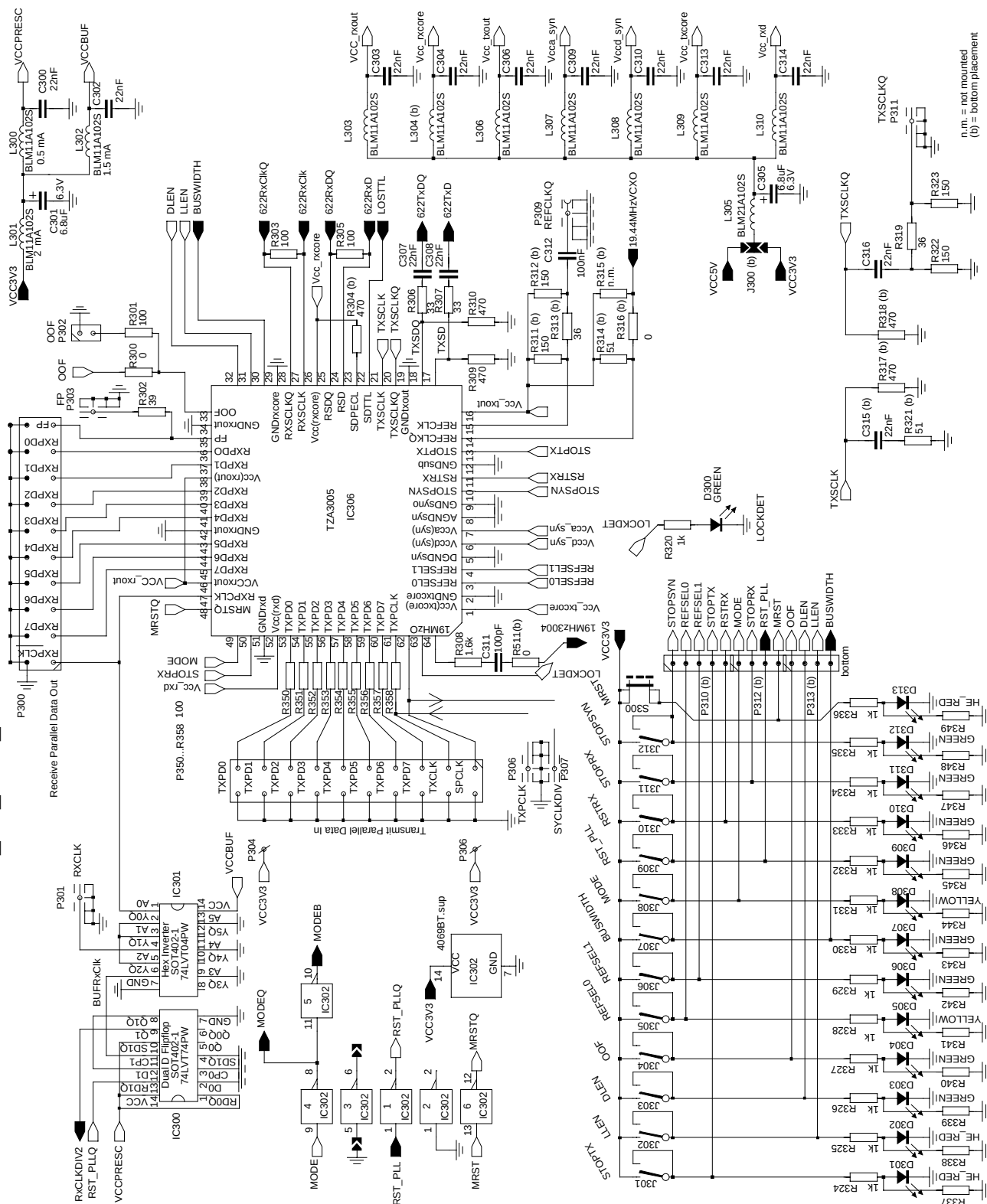
n.m. = not mounted
(b) = bottom placement

4.4 Data and Clock recovery device OQ2541: DCR (in 1250 Mbps configuration only)

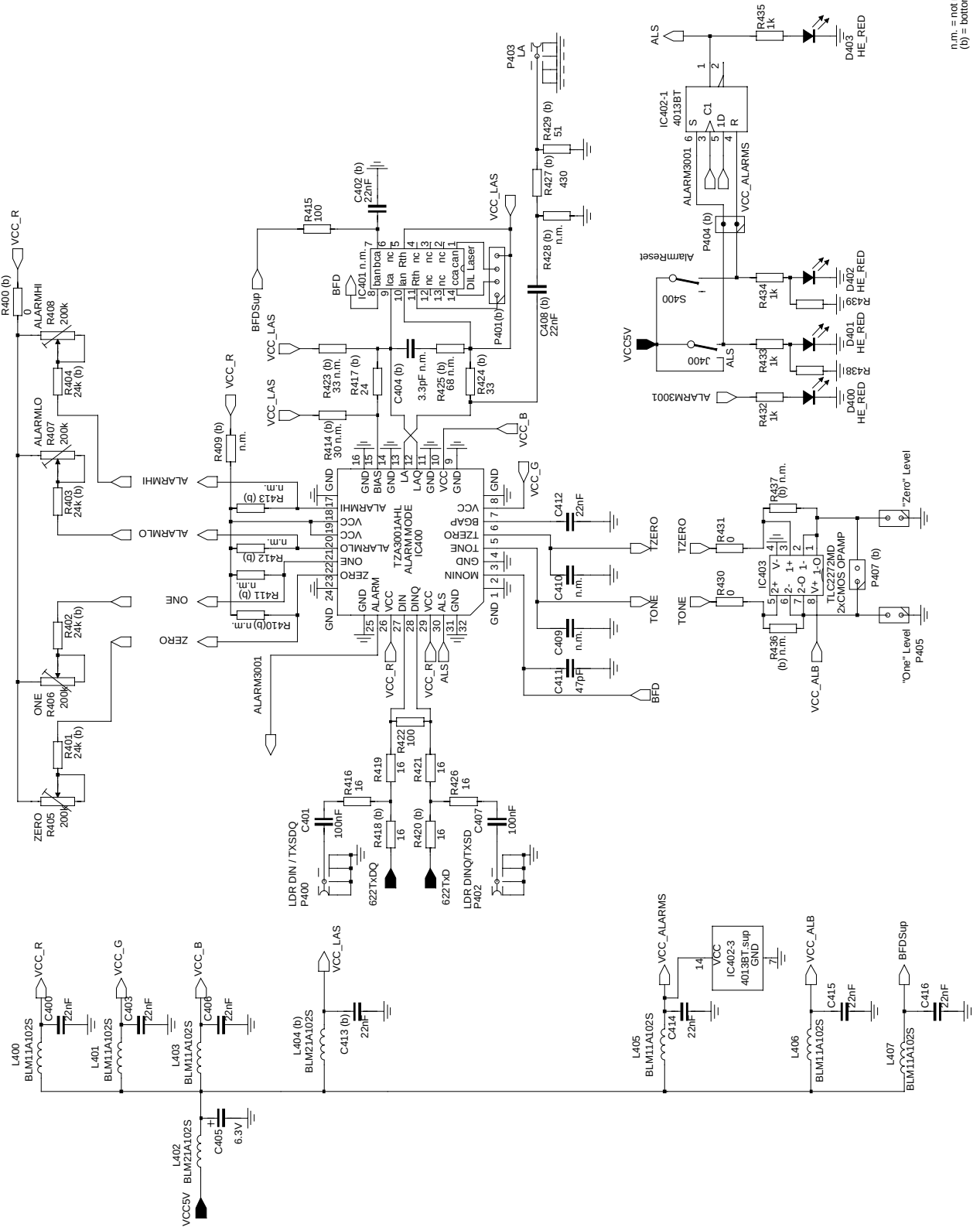


n.m. = not mounted
(b) = bottom placement

4.5

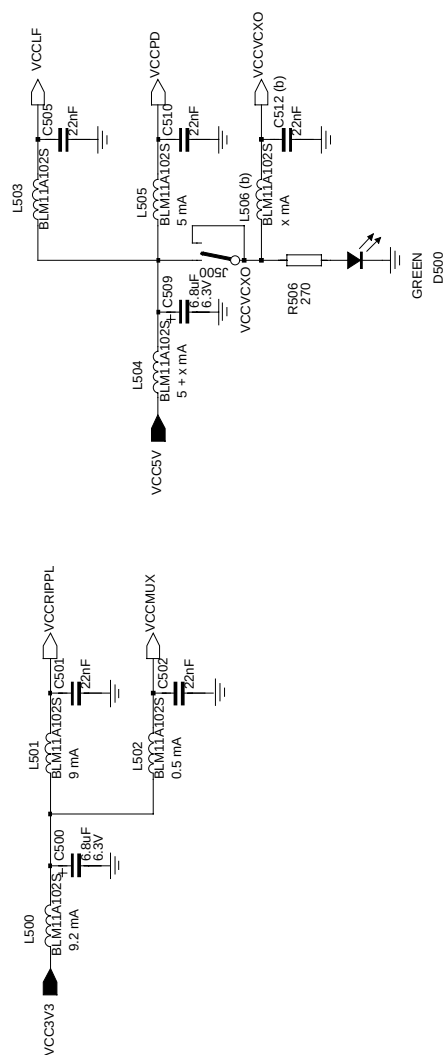
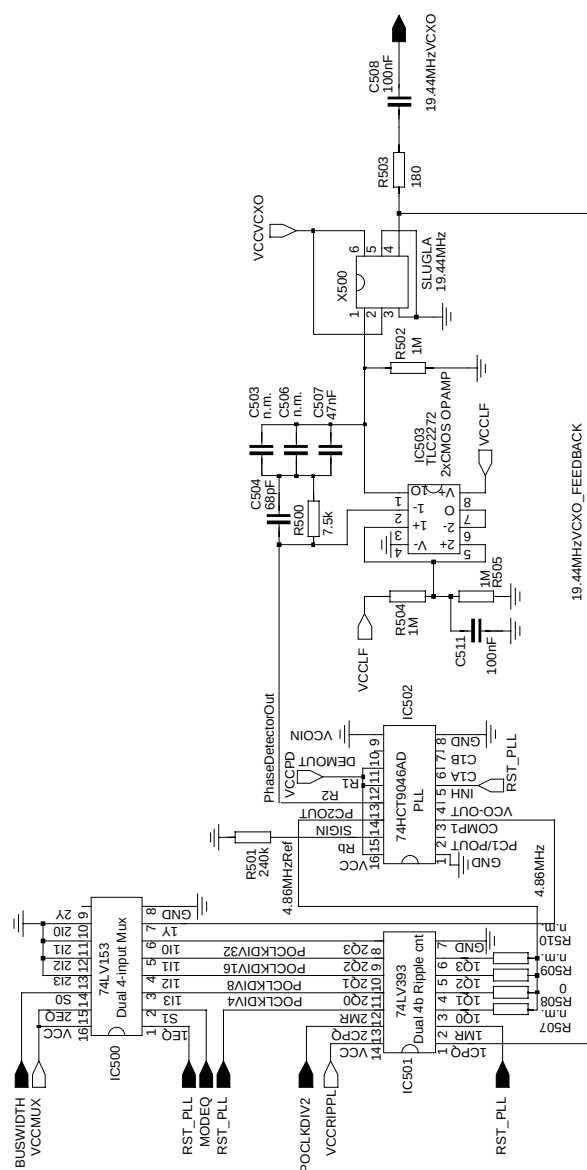


4.6 Laserdriver TZA30x1: LDR_LD



n.m. = not mounted
(b) = bottom placement

Reference PLL for loopback signal cleanup



n.m. = not mounted
(b) = bottom placement

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5. Bill of materials

TABLE 10 Bill of materials, sorted after reference number. nm=not mounted

REF	nm	Part number	Comp	Series	Vendor	Tolerance	Rating	Geom
		8222-411-47513	PR47513	OM5802	PS-SLE			BOARD
C1		B45196E1106M9	10uF	B45196	SIEMENS	20%	6.3V	B45_b
C2		B45196E1106M9	10uF	B45196	SIEMENS	20%	6.3V	B45_b
C100		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0603
C104		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0604
C105		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0605
C106		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0606
C200		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0607
C201		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0608
C202		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0609
C203		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0610
C204		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0611
C312		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0612
C401		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0613
C407		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0614
C508		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0615
C511		2222-786-16749	100nF	X7R	PHILIPS	20%	16V	C0616
C101		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0603
C103		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0604
C207		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0605
C300		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0606
C302		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0607
C303		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0608
C304		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0609
C306		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0610
C307		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0611
C308		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0612
C309		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0613
C310		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0614
C313		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0615
C314		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0616
C315		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0617
C316		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0618
C400		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0619
C402		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0620
C403		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0621
C406		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0622
C408		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0623
C412		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0624

TABLE 10 Bill of materials, sorted after reference number. nm=not mounted

REF	nm	Part number	Comp	Series	Vendor	Tolerance	Rating	Geom
C413		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0625
C414		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0626
C415		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0627
C416		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0628
C501		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0629
C502		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0630
C505		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0631
C510		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0632
C512		2222-916-16741	22nF	X7R	PHILIPS	20%	25V	C0633
C102		B45196E1156M4	6.8uF	B45196	SIEMENS	20%	6.3V	B45_c
C301		B45196E1156M4	6.8uF	B45196	SIEMENS	20%	6.3V	B45_c
C305		B45196E1156M4	6.8uF	B45196	SIEMENS	20%	6.3V	B45_c
C405		B45196E1156M4	6.8uF	B45196	SIEMENS	20%	6.3V	B45_c
C500		B45196E1156M4	6.8uF	B45196	SIEMENS	20%	6.3V	B45_c
C509		B45196E1156M4	6.8uF	B45196	SIEMENS	20%	6.3V	B45_c
C205		2222-596-16621	3.3nF	X7R	PHILIPS	10%	50V	C0603
C206		2222-786-16745	47nF	X7R	PHILIPS	20%	16V	C0603
C507		2222-786-16745	47nF	X7R	PHILIPS	20%	16V	C0604
C208		2222-960-16654	220nF	X7R	PHILIPS	10%	16V	C0805
C311		2222-867-12101	100pF	NP0	PHILIPS	5%	50V	C0603
C404	x	2222-867-12338		NP0	PHILIPS	0.25pF	50V	C0603
C409	x			C0603-X7R	PHILIPS	10%	63V	C0603
C410	x			C0603-X7R	PHILIPS	10%	63V	C0604
C503	x			C0603-X7R	PHILIPS	10%	63V	C0605
C506	x			C0603-X7R	PHILIPS	10%	63V	C0606
C411		2222-867-12479	47pF	NP0	PHILIPS	5%	50V	C0603
C504		2222-867-12689	68pF	NP0	PHILIPS	5%	50V	C0603
D100		HLMP6400-009	YELLOW	Diff-Lns	FARNELL			SMLED
D305		HLMP6400-009	YELLOW	Diff-Lns	FARNELL			SMLED
D308		HLMP6400-009	YELLOW	Diff-Lns	FARNELL			SMLED
D101		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D200		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D201		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D300		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D303		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D304		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D306		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D307		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D309		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D310		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED

TABLE 10 Bill of materials, sorted after reference number. nm=not mounted

REF	nm	Part number	Comp	Series	Vendor	Tolerance	Rating	Geom
D311		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D312		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D500		HLMP6500-011	GREEN	Diff-Lns	FARNELL			SMLED
D102		HLMP6300-011	HE_RED	Diff-Lns	FARNELL			SMLED
D301		HLMP6300-011	HE_RED	Diff-Lns	FARNELL			SMLED
D302		HLMP6300-011	HE_RED	Diff-Lns	FARNELL			SMLED
D313		HLMP6300-011	HE_RED	Diff-Lns	FARNELL			SMLED
D400		HLMP6300-011	HE_RED	Diff-Lns	FARNELL			SMLED
D401		HLMP6300-011	HE_RED	Diff-Lns	FARNELL			SMLED
D402		HLMP6300-011	HE_RED	Diff-Lns	FARNELL			SMLED
D403		HLMP6300-011	HE_RED	Diff-Lns	FARNELL			SMLED
D202		HLMP6000-011	RED	Diff-Lns	FARNELL			SMLED
IC100		9351-889-50512	74HC151PW		PHILIPS			SOT403
IC101		PN-TZA3000	TZA3000	ICuniv	*			SOT401
IC200		PN-TZA3004HL	TZA3004HL	ICuniv	*			SOT313
IC300		PN-74LVT74PW	74LVT74PW	ICuniv	*			SOT402
IC301		PN-74LVT04PW	74LVT04PW	ICuniv	*			SOT402
IC302		9333-730-00652	4069BT	HEF	PHILIPS			SOT108
IC303		PN-TZA3005	TZA3005	ICuniv	*			SOT393
IC400		PN-TZA3001	TZA3001	ICuniv	*			SOT401
IC401		PN-DILLaser	DIL-Laser	ICuniv	*			SOT27_s
IC402		9333-726-60652	4013BT	HEF	PHILIPS			SOT108
IC403		PN-TLC2272MD	TLC2272MD	ICuniv	*			SOT96
IC503		SLUGLA19.44	VCXO		VECTRON			6pin
IC500		PN-74LV153PW	74LV153PW	ICuniv	*			SOT403
IC501		PN-74LV393PW	74LV393PW	ICuniv	*			SOT402
IC502		PN-74HCT9046AD		ICuniv	*			SOT403
J100		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J101		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J200		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J301		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J302		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J303		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J304		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J305		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J306		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J307		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J308		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J309		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J310		09-03-201-02	SPDT	pr-sw	Spoele			SPDT

TABLE 10 Bill of materials, sorted after reference number. nm=not mounted

REF	nm	Part number	Comp	Series	Vendor	Tolerance	Rating	Geom
J311		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J312		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J400		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
J500		09-03-201-02	SPDT	pr-sw	Spoele			SPDT
L100		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L101		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L102		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L300		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L301		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L302		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L303		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L304		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L306		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L307		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L308		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L309		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L310		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L400		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L401		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L403		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L405		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L406		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L407		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L500		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L501		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L502		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L503		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L504		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L505		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L506		L-0603CS	BLM11A102S	0603CS	*			L0603cs
L200		L-0805CS	BLM21A102S	0805CS	Coilcrt			L0805cs
L305		L-0805CS	BLM21A102S	0805CS	Coilcrt			L0805cs
L402		L-0805CS	BLM21A102S	0805CS	Coilcrt			L0805cs
L404		L-0805CS	BLM21A102S	0805CS	Coilcrt			L0805cs
P1		MKS3733-1-0-303	MKS3730_3p	MKS3730	STOCKO			M3p
P100		05-88-1536	ar_bus_1x2p		DISPLAY			1x2p
P104		05-88-1536	ar_bus_1x2p		DISPLAY			1x2p
P105		05-88-1536	ar_bus_1x2p		DISPLAY			1x2p
P204		05-88-1536	ar_bus_1x2p		DISPLAY			1x2p
P404		05-88-1536	ar_bus_1x2p		DISPLAY			1x2p

TABLE 10 Bill of materials, sorted after reference number. nm=not mounted

REF	nm	Part number	Comp	Series	Vendor	Tolerance	Rating	Geom
P407		05-88-1536	ar_bus_1x2p		DISPLAY			1x2p
P101		R114426	SMB_str	COAX	RADIALL			SMB
P311		R114426	SMB_str	COAX	RADIALL			SMB
P102		PCB-EXP-GEOM	Shield		*			3p
P103			SMA_ed	COAX	JOHNSON			SMAe
P107			SMA_ed	COAX	JOHNSON			SMAe
P200			SMA_ed	COAX	JOHNSON			SMAe
P201			SMA_ed	COAX	JOHNSON			SMAe
P202			SMA_ed	COAX	JOHNSON			SMAe
P203			SMA_ed	COAX	JOHNSON			SMAe
P403		05-88-1136	ar_1x2p		DISPLAY			1x2p
P302		05-88-1136	ar_1x2p		DISPLAY			1x2p
P405		05-88-1136	ar_1x2p		DISPLAY			1x2p
P406		05-88-1136	ar_1x2p		DISPLAY			1x2p
P18		PCB-EXP-GEOM			*			10p
P2		05-88-1536	ar_bus_1x3p		DISPLAY			1x3p
P300		05-88-1236	ar_2x10p		DISPLAY			2x10p
P305		05-88-1236	ar_2x10p		DISPLAY			2x10p
P301		R114665	SMB_clk-s	COAX	RADIALL			SMBq
P303		R114665	SMB_clk-s	COAX	RADIALL			SMBq
P307		R114665	SMB_clk-s	COAX	RADIALL			SMBq
P308		R114665	SMB_clk-s	COAX	RADIALL			SMBq
P304		2422-034-15068	solder_pin		PHILIPS			1x1p
P306		2422-034-15068	solder_pin		PHILIPS			1x1p
P309			SMA_ed	COAX	JOHNSON			SMAe
P400			SMA_ed	COAX	JOHNSON			SMAe
P402			SMA_ed	COAX	JOHNSON			SMAe
P310		05-88-1536	ar_bus_1x4p		DISPLAY			1x5p
P312		05-88-1536	ar_bus_1x4p		DISPLAY			1x4p
P313		05-88-1536	ar_bus_1x4p		DISPLAY			1x4p
P401		05-88-1536	ar_bus_1x4p		DISPLAY			1x4p
R100		2122-362-00727	20k	3296Y	BOURNS	10%	0.5W	BO3296Y
R101		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603
R102		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603
R112		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603
R300		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603
R316		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603
R400		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603
R430		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603
R431		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603

TABLE 10 Bill of materials, sorted after reference number. nm=not mounted

REF	nm	Part number	Comp	Series	Vendor	Tolerance	Rating	Geom
R508		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603
R511		2322-702-96001	0	RC21	PHILIPS	5%	0.063W	R0603
R103		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R104		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R111		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R200		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R201		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R203		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R204		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R207		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R320		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R324		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R325		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R326		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R327		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R328		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R329		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R330		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R331		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R332		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R333		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R334		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R335		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R336		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R432		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R433		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R434		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R435		2322-702-60102	1k	RC21	PHILIPS	5%	0.063W	R0603
R105		2322-180-73821	820	SFR16T	PHILIPS	5%	0.5W	SFR16T
R106		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R107		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R202		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R337		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R338		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R339		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R340		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R341		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R342		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R343		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R344		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603

TABLE 10 Bill of materials, sorted after reference number. nm=not mounted

REF	nm	Part number	Comp	Series	Vendor	Tolerance	Rating	Geom
R345		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R346		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R347		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R348		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R349		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R438		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R439		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R502		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R504		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R505		2322-702-60105	1M	RC21	PHILIPS	5%	0.063W	R0603
R108		2322-702-60519	51	RC21	PHILIPS	5%	0.063W	R0603
R314		2322-702-60519	51	RC21	PHILIPS	5%	0.063W	R0603
R321		2322-702-60519	51	RC21	PHILIPS	5%	0.063W	R0603
R429		2322-702-60519	51	RC21	PHILIPS	5%	0.063W	R0603
R109		2322-704-68203	82k	RC22H	PHILIPS	1%	0.063W	R0603
R110	x	RES-704-R0603	x	RC11	PHILIPS	1%	0.1W	R0603
R206	x	RES-704-R0603	x	RC11	PHILIPS	1%	0.1W	R0603
R315	x	RES-704-R0603	x	RC11	PHILIPS	1%	0.1W	R0603
R428	x	RES-704-R0603	x	RC11	PHILIPS	1%	0.1W	R0603
R436	x	RES-704-R0603	x	RC11	PHILIPS	1%	0.1W	R0603
R437	x	RES-704-R0603	x	RC11	PHILIPS	1%	0.1W	R0603
R507	x	RES-704-R0603	x	RC11	PHILIPS	1%	0.1W	R0603
R509	x	RES-704-R0603	x	RC11	PHILIPS	1%	0.1W	R0603
R510	x	RES-704-R0603	x	RC11	PHILIPS	1%	0.1W	R0603
R113		2322-702-60563	56k	RC21	PHILIPS	5%	0.063W	R0603
R114		2322-702-60471	470	RC21	PHILIPS	5%	0.063W	R0603
R115		2322-702-60471	470	RC21	PHILIPS	5%	0.063W	R0603
R304		2322-702-60471	470	RC21	PHILIPS	5%	0.063W	R0603
R309		2322-702-60471	470	RC21	PHILIPS	5%	0.063W	R0603
R310		2322-702-60471	470	RC21	PHILIPS	5%	0.063W	R0603
R317		2322-702-60471	470	RC21	PHILIPS	5%	0.063W	R0603
R318		2122-362-00728	50k	3296Y	BOURNS	10%	0.5W	BO3296Y
R205		2322-702-60308	3	RC21	PHILIPS	5%	0.063W	R0603
R208		2322-702-60103	10k	RC21	PHILIPS	5%	0.063W	R0603
R301		2322-711-61101	100	RC01	PHILIPS	5%	0.25W	R1206
R302		2322-702-60399	39	RC21	PHILIPS	5%	0.063W	R0603
R303		2322-704-61001	100	RC22H	PHILIPS	1%	0.063W	R0603
R305		2322-704-61001	100	RC22H	PHILIPS	1%	0.063W	R0603
R422		2322-704-61001	101	RC22H	PHILIPS	1%	0.063W	R0603
R306		2322-702-60339	33	RC21	PHILIPS	5%	0.063W	R0603

TABLE 10 Bill of materials, sorted after reference number. nm=not mounted

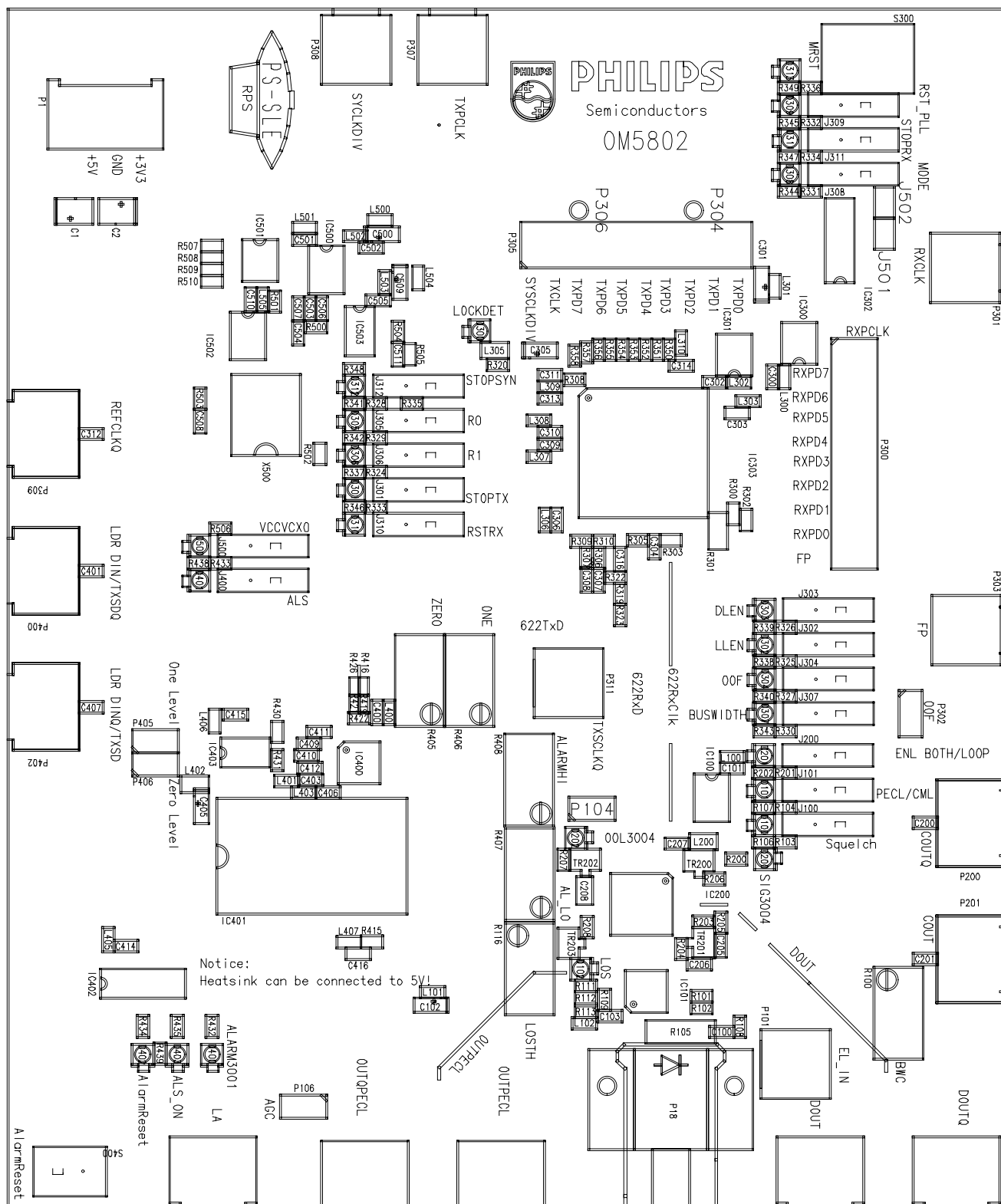
REF	nm	Part number	Comp	Series	Vendor	Tolerance	Rating	Geom
R307		2322-702-60339	33	RC21	PHILIPS	5%	0.063W	R0603
R308		2322-702-60162	1.6k	RC21	PHILIPS	5%	0.063W	R0603
R311		2322-702-60151	150	RC21	PHILIPS	5%	0.063W	R0603
R312		2322-702-60151	150	RC21	PHILIPS	5%	0.063W	R0603
R322		2322-702-60151	150	RC21	PHILIPS	5%	0.063W	R0603
R323		2322-702-60151	150	RC21	PHILIPS	5%	0.063W	R0603
R313		2322-702-60369	36	RC21	PHILIPS	5%	0.063W	R0603
R319		2322-702-60369	36	RC21	PHILIPS	5%	0.063W	R0603
R350		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R351		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R352		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R353		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R354		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R355		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R356		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R357		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R358		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R415		2322-702-60101	100	RC21	PHILIPS	5%	0.063W	R0603
R401		2322-702-60243	24k	RC21	PHILIPS	5%	0.063W	R0603
R402		2322-702-60243	24k	RC21	PHILIPS	5%	0.063W	R0603
R403		2322-702-60243	24k	RC21	PHILIPS	5%	0.063W	R0603
R404		2322-702-60243	24k	RC21	PHILIPS	5%	0.063W	R0603
		2322-702-60243	24k	RC21	PHILIPS	5%	0.063W	R0603
R405		2122-362-00731	200k	3296Y	BOURNS	10%	0.5W	B3296Y
R406		2122-362-00731	200k	3296Y	BOURNS	10%	0.5W	B3296Y
R407		2122-362-00731	200k	3296Y	BOURNS	10%	0.5W	B3296Y
R408		2122-362-00731	200k	3296Y	BOURNS	10%	0.5W	B3296Y
R409	x			RC21	PHILIPS	5%	0.063W	R0603
R410	x			RC22H	PHILIPS	1%	0.063W	R0603
R411	x			RC22H	PHILIPS	1%	0.063W	R0603
R412	x			RC22H	PHILIPS	1%	0.063W	R0603
R413	x			RC22H	PHILIPS	1%	0.063W	R0603
R414		2322-711-61309	30	RC01	PHILIPS	5%	0.25W	R1206
R416		RES-R0402	16		PHILIPS	1%	0.1W	R0402
R418		RES-R0402	16		PHILIPS	1%	0.1W	R0402
R419		RES-R0402	16		PHILIPS	1%	0.1W	R0402
R420		RES-R0402	16		PHILIPS	1%	0.1W	R0402
R421		RES-R0402	16		PHILIPS	1%	0.1W	R402
R426		RES-R0402	16		PHILIPS	1%	0.1W	R0402
R417	x			RC01	PHILIPS	5%	0.25W	R1206

TABLE 10 Bill of materials, sorted after reference number. nm=not mounted

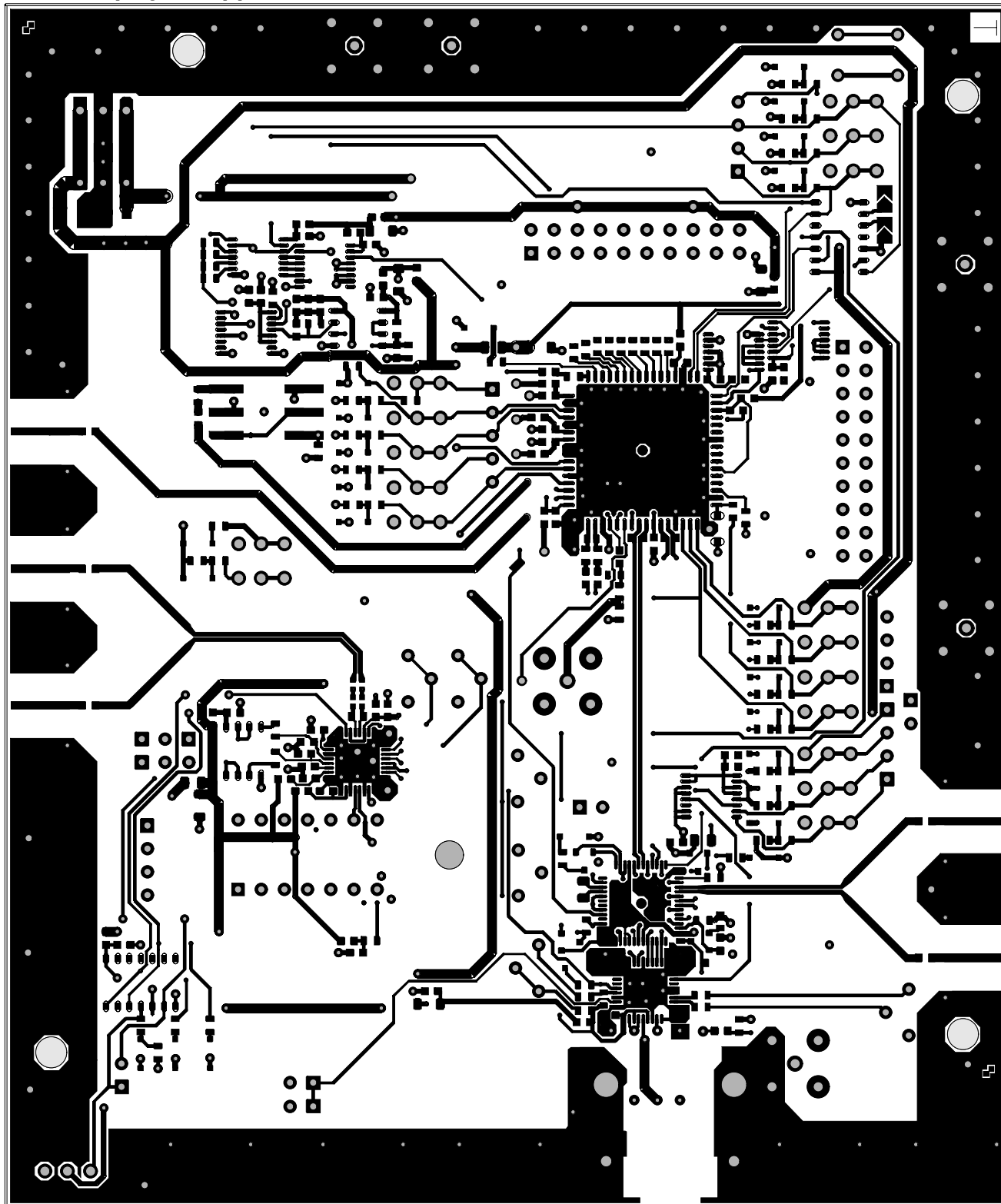
REF	nm	Part number	Comp	Series	Vendor	Tolerance	Rating	Geom
R423		2322-730-61339	33	RC11	PHILIPS	5%	0.1W	R0805
R424		2322-730-61340	33	RC11	PHILIPS	5%	0.1W	R0806
R425	x			RC21	PHILIPS	5%	0.063W	R0603
R427		2322-702-60431	430	RC21	PHILIPS	5%	0.063W	R0603
R500		2322-702-60823	82k	RC21	PHILIPS	5%	0.063W	R0603
R501		2322-702-60244	240k	RC21	PHILIPS	5%	0.063W	R0603
R503		2322-702-60181	180	RC21	PHILIPS	5%	0.063W	R0603
R506		2322-702-60271	270	RC21	PHILIPS	5%	0.063W	R0603
S300		RODELCO-4972-998	SKHHAN	pr-sw	ALPS			Mxh
S400		FARNELL-150-559	SPDT	pr-sw	MORS			SPDT
TR200		9335-897-40212	BC857		PHILIPS			SOT23
TR202		9335-897-40212	BC857		PHILIPS			SOT23
TR201		9332-096-40212	BCX19		PHILIPS			SOT23
TR203		PN-BSH103	BSH103	fets	PHILIPS			SOT23
X500		PN-SLUGLA	SLUGLA	ICuniv	*			SOT228
IC401		2422-549-13264	DIL14			SOT27_s		
P309		142-0701-851	Thomson			SMA_str		
P400		142-0701-852	Thomson			SMA_str		
P404		142-0701-853	Thomson			SMA_str		

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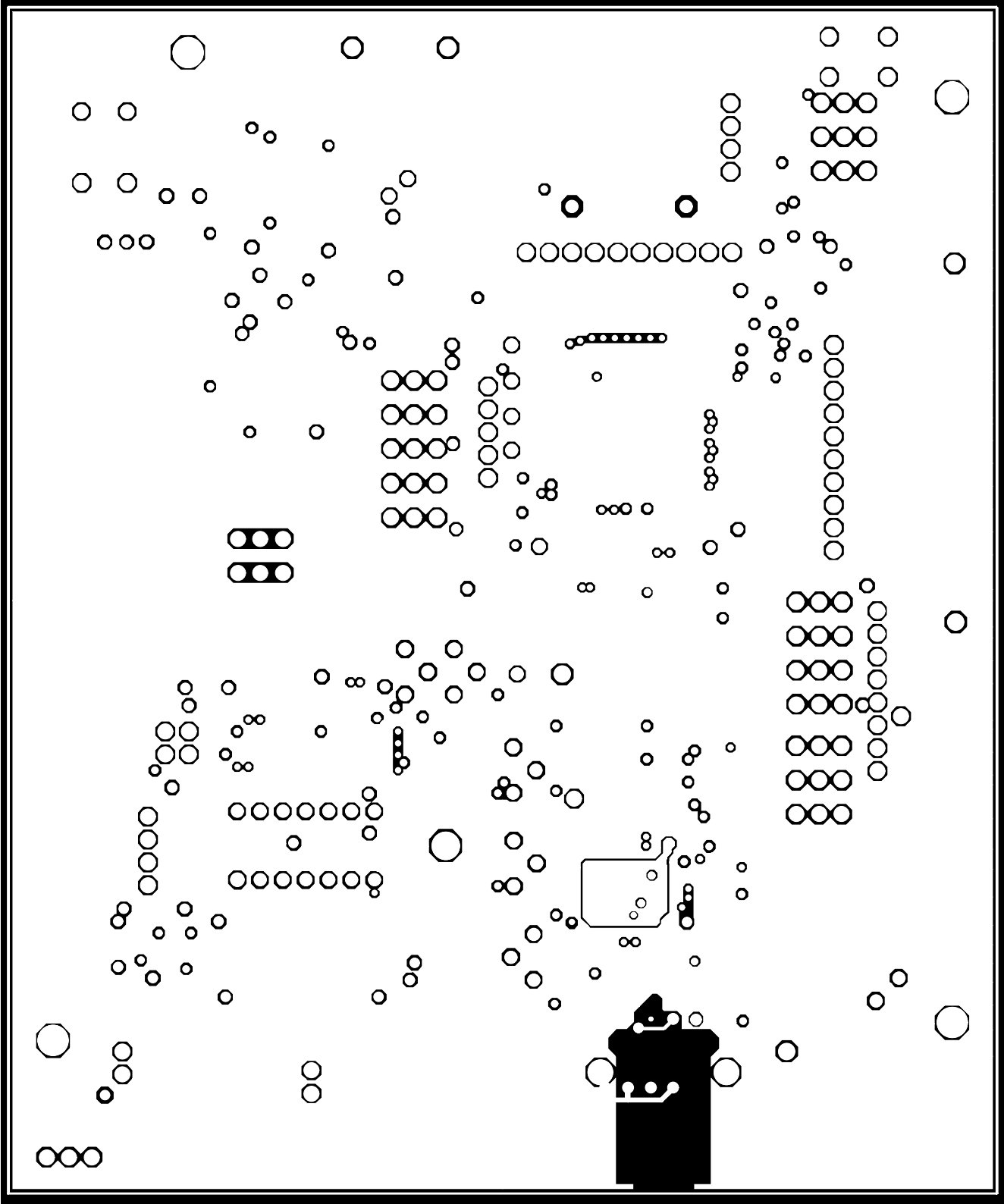
6.1 Silkscreen



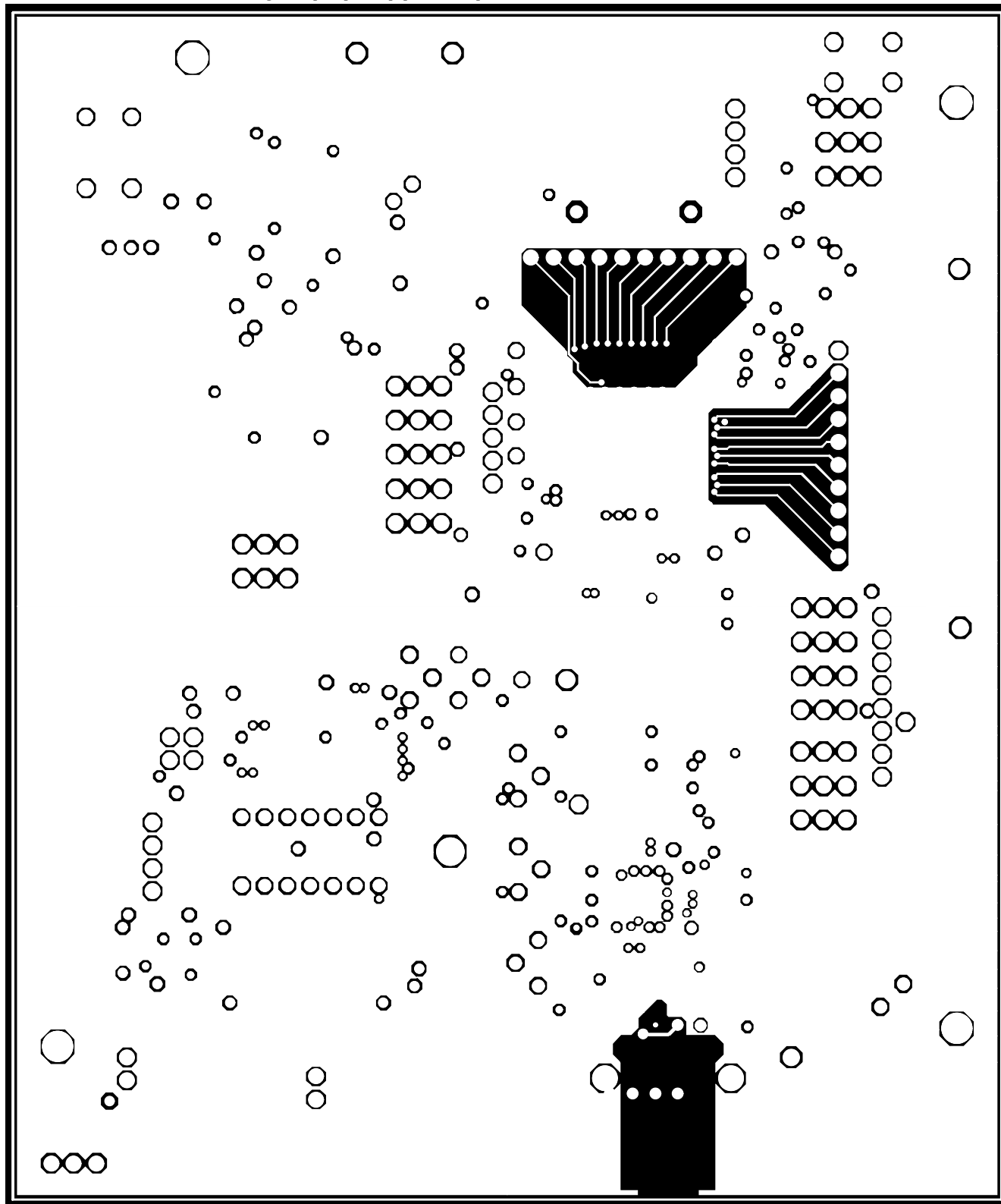
6.3 Toplayer copper



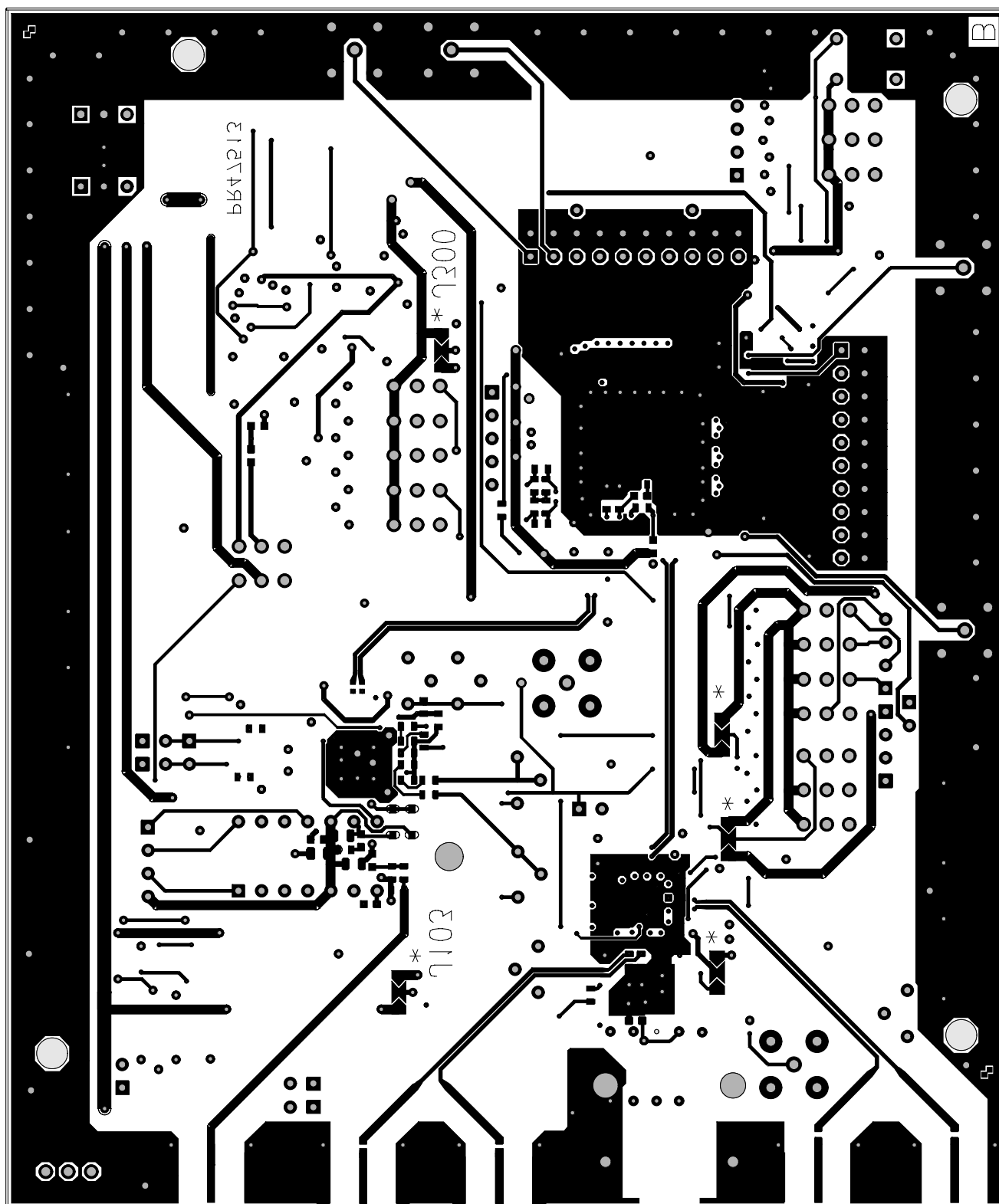
6.4 First inner layer (#3) copper, inverted



6.5 Second inner layer (#4) copper, topview



6.6 Bottom layer (#2) copper topview



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