19-2348; Rev 0; 2/02

MAX3865 Evaluation Kit

Evaluates: MAX3865

General Description

The MAX3865 evaluation kit (EV kit) has one circuit for electrical evaluation and a second circuit for optical evaluation. The electrical EV board is designed to familiarize the user with the behavior of the automatic power control (APC) and automatic modulation control (AMC) features of the MAX3865 in an environment that is easy to instrument using the many test points provided. The optical EV board closely resembles what might be found in an actual communications environment.

The electrical part of the EV kit is designed to familiarize the user with the controlling action of the MAX3865. The kit contains a synthetic laser plus monitor diode, for which threshold current and gain can be varied through jumper connections. The user can program values for the bias (average) and modulation (peak-to-peak) currents in the monitor diode for a desired extinction ratio. The synthetic laser can be changed to simulate variation of temperature or approaching end of life, and the extinction ratio is held constant. Parameters such as loop settling time or the restrictions imposed on the maximum currents in the laser can also be observed.

Features

- ♦ **Fully Assembled and Tested**
- ♦ **Fully Matched for Best Return Loss**

Ordering Information

PART	TEMP RANGE	IC PACKAGE
MAX3865EVKIT	-40°C to +85°C	32 QFN

Electrical Component List

DESIGNATION	QTY	DESCRIPTION
C11–C14, C20	5	0.1µF ±10%, 10V ceramic capacitors (0402)
C15–C18, C22, C26	6	0.01µF ±10%, 10V ceramic capacitors (0402)
C19	1	47pF ±5%, 10V ceramic capacitor (0402)
C21	1	22pF ±5%, 10V ceramic capacitor (0402)
C23, C24	2	10µF ±10%, 10V tantalum capacitors
C25	1	0.01µF ±10%, 10V ceramic capacitor (0603)
C36–C39	0	Do not install (0402)
D11, D13	2	Rectifier diodes, 1A Digi-Key S1ADICT-ND
D12	1	Red LED, T1 pkg Digi-Key 363-ND
J3, J4, J5	3	Test points
J11–J15	5	SMA connectors (edge mount, round contact) EFJohnson 142-0701-801 or Digi-Key J502-ND **Note:** Cut center pin to approximately 1/16in length.
JU11–JU18	8	1-pin × 2-pin headers (0.1in centers)
JU11–JU18	8	Shunts
L12, L13	2	1.2µH inductors Coilcraft 1008 LS-122XKBC
Q11	1	PNP transistor Central Semiconductor CMPT3906
R9	1	100Ω ±1% resistor (0402)
R11, R12, R13	3	33kΩ ±5% resistors (0603)
R14–R17	4	3.3kΩ ±5% resistors (0603)
R18, R19	2	200Ω ±1% resistors (0402)
R20	1	20Ω ±5% resistor (2010)
R21	1	10Ω ±1% resistor (1210)
R22	1	33Ω ±1% resistor (0603)
R23	1	2kΩ ±1% resistor (0603)
R24	1	1.0kΩ ±1% resistor (0603)

Electrical Component List (continued)

DESIGNATION	QTY	DESCRIPTION
R25–R28	4	100kΩ variable resistors Bourns 3296W or Digi-Key 3296W-104-ND
R29, R30	2	10kΩ ±1% resistors (0402)
TP1, TP4, TP12, TP13, TP14, TP16, TP17	7	Test points
U11	1	MAX3865 EGJ 32-pin QFN **Note:** U11 has an exposed paddle that requires that it be solder attached to the circuit board to ensure proper functionality of the part.

Optical Component List

DESIGNATION	QTY	DESCRIPTION
C3	1	10µF ±10%, 10V tantalum capacitor
C4	1	0.01µF ±10%, 10V ceramic capacitor (0603)
C40–C43	0	Do not install (0402)
C51–C54	4	0.1µF ±10%, 10V ceramic capacitors (0402)
C55–C58, C63	5	0.01µF ±10%, 10V ceramic capacitors (0402)
C59, C60	2	0.1µF ±10%, 10V ceramic capacitors (0603)
C61	1	1pF ±0.1pF, 10V ceramic capacitor (0402)
D2	1	User-supplied diode
D51	1	Rectifier diode, 1A Digi-Key S1ADICT-ND
D52	1	Red LED, T1 pkg Digi-Key P363-ND
J51–J54	4	SMA connectors, edge mount (round contact) EFJohnson 142-0701-801 or Digi-Key J502-ND **Note:** Cut center pin to approximately 1/16in length.

Optical Component List (continued)

DESIGNATION	QTY	DESCRIPTION
JU51, JU52, JU53, JU56	4	1 × 2 pin headers, 0.1in centers
JU51, JU52, JU53, JU56	4	Shunts
L52	1	1.2µH inductor Coilcraft 1008CS-122XKBC
L53, L54	2	4µH inductors BLM11A102S (0805)
L55, L56, L57	3	2µH inductors BLM11HA471SG (0603)
L58	1	10µH inductor Coilcraft DO1608C-103
R2	1	10kΩ ±1% resistor (0402)
R3, R4, R6, R7	0	Do not install (0402)
R8, R62	2	100Ω ±1% resistors (0402)
R51, R52, R53	3	33kΩ ±5% resistors (0603)
R54–R57	4	3.3kΩ ±5% resistors (0603)
R58, R59	2	200Ω ±1% resistors (0402)
R60	1	20Ω resistor (0402)
R61	1	24.9Ω resistor (0402)
R65–R68	4	100kΩ variable resistors Bourns 3296W or Digi-Key 3296W-253-ND
U51	1	MAX3865EGJ 32-pin QFN **Note:** U1 has an exposed paddle that requires that it be solder attached to the circuit board to ensure proper functionality of the part.
VCC2, GND, TP2, TP3, TP52, TP53, TP54	7	Test points
None	1	MAX3865 EV kit circuit board, rev C
None	1	MAX3865 EV kit data sheet
None	1	MAX3865 data sheet

Component Suppliers

SUPPLIER	PHONE	FAX
AVX	843-444-2863	843-626-3123
EFJohnson	402-474-4800	402-474-4858
Murata	415-964-6321	415-964-8165

Note: *Please indicate that you are using the MAX3865 when contacting these component suppliers.*

Quick Start

Electrical Evaluation

1) Data and clock Input levels—set the data rate at 20Mbps (10MHz) to allow measurement of the AC current from the synthetic monitor diode with an oscilloscope. If you are using relatively low-speed data (up to about 100Mbps), it is acceptable to use a single-ended input rather than fully differential. Amplitude can be in the range:

   a) Peak-to-peak differential voltage: 200mV to 1600mV

   b) Instantaneous voltage at any input pin: 1.3V to (V_{CC} + 0.4V)

   A convenient choice is 250mV peak-to-peak to DATA+ with V_{DR} connected to V_{CC} at JU18.

   Unless you are concerned about at-speed testing of rise time or jitter, do not use the retiming feature of the MAX3865 in the electrical EV kit.

2) Connector J15 must be connected to ground via 50Ω at all times. This can be a 50Ω resistor at the connector, or a properly terminated 50Ω line to an oscilloscope. Including the back-terminating resistor R22, the peak-to-peak data voltage at J15 is:

   $$V_{P-P}\ (J15) = I_{MOD} \times 20\Omega$$

   Note that this voltage is AC-coupled, with a time constant of 8µs. The output from the MODN pin is inverted because the MODQ pin is required for the synthetic laser; MODN is terminated in a dummy load when an actual laser is used.

3) Program the gain of the synthetic laser using the jumper settings shown in Table 1. Remember that the synthetic laser is not a real laser. It mimics only some characteristics of a real laser. In particular, its input behaves like a linear resistor and not like a diode. As input current is increased, synthetic laser voltage continues to increase rather than saturating (at something in excess of 1V) like a real laser (Figure 1).

4) AMC is the preferred operating mode for the MAX3865. Average optical power output and extinction ratio are automatically held constant. Program the bias and modulation currents using the AMC and APC set points.

   Set the laser parameters from Table 1:

   $$I_{THRESHOLD} = 20mA$$

   $$\text{LASER Gain} = 0.01$$

   Program the AMC and APC set points:

   $$I_{APC} = 5 \times \frac{1.2V}{R27 + 2k\Omega + 3.3k\Omega}$$

   $$I_{AMC} = 5 \times \frac{1.2V}{R28 + 2k\Omega + 3.3k\Omega}$$

   $$I_{APC} = 250\mu A \text{ for } R27 = 18.7k\Omega$$

   $$I_{AMC} = 250\mu A \text{ for } R28 = 18.7k\Omega$$

Table 1. Synthetic Laser Gain Settings

GAIN SLOPE ($\Delta I_{MD}/\Delta I_{MODQ}$)	$\frac{1}{33}$	$\frac{1}{100}$	$\frac{1}{100}$	$\frac{1}{300}$
Threshold Current	≈20mA	≈20mA	≈60mA	≈60mA
JU14	Open	Open	Short	Short
JU15	Short	Open	Short	Open
JU16 (MDX)	Short	Open or short	Open or short	Open

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The resulting bias and modulation currents as seen in Figure 1:

$$I_{BIAS} = I_{THRESHOLD} + \frac{I_{APC}}{GAIN} - \frac{1}{2} \times \frac{I_{AMC}}{GAIN}$$

or

$$I_{BIAS} = 32.5mA$$

$$I_{MOD} = \frac{I_{AMC}}{Gain} \text{ or } I_{MOD} = 25mA$$

The bias and modulation currents can be verified by using a voltmeter to measure $V_{BIASMON}$ from TP14 to TP12 and V_{MODMON} from TP14 to TP13:

$$I_{BIAS} = \frac{48 \times V_{BIASMON}}{200}$$

$$I_{MOD} = \frac{32 \times V_{MODMON}}{200}$$

The corresponding monitor currents: $I_{BIASMON} \approx 677\mu A$ and $I_{MODMON} \approx 781\mu A$. See Figure 1 to see how the set-point currents and actual bias and modulation currents are related.

5) Set V_{CC} = 3.3V. Remember that the operating voltages at the MAX3865 output pins must at all times satisfy the minimum voltages for compliance:

   V_{BIAS} or $V_{BIASX} \geq 1.0V$

   V_{MODQ} or $V_{MODN} \geq 1.8V$

   $V_{BIAS} = V_{CC\_LASER} - (I_{BIAS} + I_{MOD}) \times 10\Omega$, if JU14 is short

   $V_{BIAS} = V_{CC\_LASER} - (I_{BIAS} + I_{MOD}) \times 30\Omega$, if JU14 is open

   Min $V_{MODN} = V_{CC\_LASER} - I_{MOD} \times 30\Omega$

   The operating voltages must also satisfy the maximum voltages for compliance:

   V_{BIAS} or $V_{BIAS\_X} \leq$ (chip V_{CC} + 0.4V)

   V_{MODQ} or $V_{MODN} \leq$ (chip V_{CC} + 1.2V)

   To satisfy these constraints, the V_{CC_LASER} for the synthetic laser must be disconnected from the main supply to the chip (at JU17), and connected to some higher voltage. For the currents programmed in step 4, set V_{CC_LASER} = 4.5V.

6) The synthetic laser current can be observed by the voltage difference between JU14 and TP17. The total current flows in 10Ω resistor R21, but note that its bandwidth is restricted to about 100MHz by the combination of C19 and the input capacitance of the test oscilloscope. Similarly, the current in the

Table 2. Test Setup Summary for the AMC Mode with the Electrical EV Kit

COMPONENT	STATE	COMMENT
J11 (DATA-)	Unconnected	—
J12 (DATA+)	Data in	250mV$_{P-P}$ at 20Mbps (10MHz)
J13 (CLK+)	Unconnected	—
J14 (CLK-)	Unconnected	—
JU11	Short circuit	Disable data latch
JU12	Open circuit	Enable AMC mode
JU13	Open circuit	Enable AMC mode
JU14	Open circuit	Set laser gain and threshold
JU15	Open circuit	Set laser gain and threshold
JU16	Open circuit	Disconnect monitor-diode shunt
JU17	Open circuit	Use $V_{CC\_LASER} \approx$ (VCC + 1)
JU18	Short circuit	Set data reference VDR = VCC
R25	Fully clockwise	Set laser $i_{BIASMAX}$ = 100mA
R26	Fully clockwise	Set laser i_{MODMAX} = 60mA
R27	Approximately 20kΩ	Set monitor-diode $i_{APC} \approx 250\mu A$
R28	Approximately 20kΩ	Set monitor-diode $i_{AMC} \approx 250\mu A$

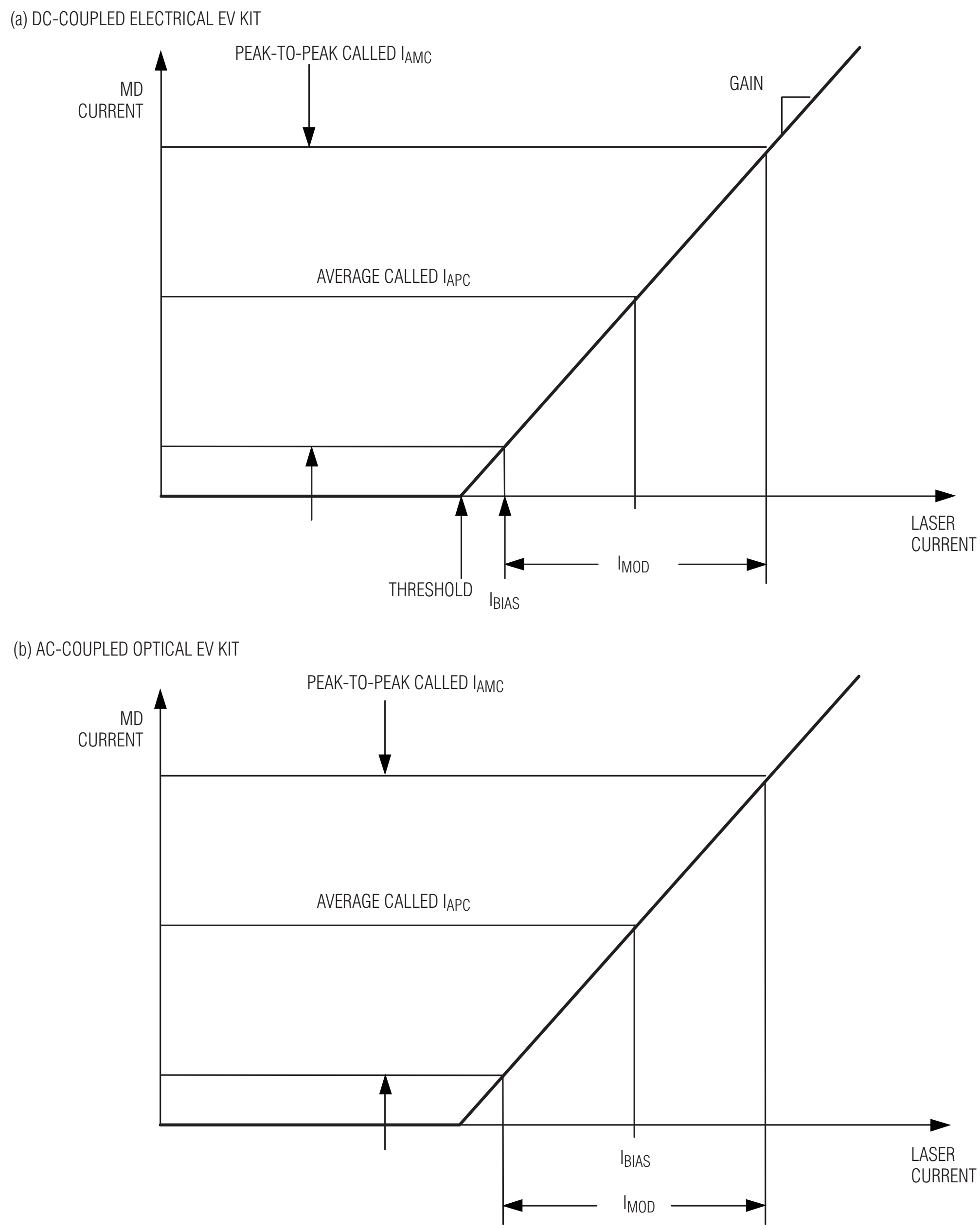

Figure 1. Relation Between Chip-Output Currents and Monitor-Diode Currents

monitor diode can be observed by the voltage difference between TP16 and TP17; this current flows in 1kΩ resistor R24.

The synthetic laser is sensitive to stray capacitance at JU14 and TP16. When measuring DC voltages, connect a 100kΩ resistor in series with the meter, and physically locate this resistor close to the test point. When observing waveforms, use a high-impedance probe with <15pF input capacitance. It is helpful to use a differential oscilloscope, with its +input at JU14/TP16 and its -input at TP17.

7) Now change the laser threshold to approximately 60mA:

   JU14 ⇒ short-circuit

   JU15 ⇒ short-circuit

   - Average and peak-to-peak currents I_{APC} and I_{AMC} in the monitor diode do not change from the values programmed by R27 and R28. Optical power output is held constant by MAX3865, despite changes in the laser characteristics.
   - Bias current in the laser changes as required to compensate for the change in threshold: $I_{BIAS} \approx$ 72.5mA and $I_{BIASMON} \approx$ 1510µA.
   - Peak-to-peak current in the laser should remain constant, but may in fact change slightly because the gain of the laser does not remain precisely constant when JU14 and JU15 are changed: $I_{MOD} \approx$ 25mA and $I_{MODMON} \approx$ 781µA.

8) Change the laser again to 20mA threshold and 0.03 gain:

   JU14 ⇒ open circuit

   JU15 ⇒ short circuit

   - Average and peak-peak currents in the monitor diode should not change.
   - Laser currents change as required to compensate for the changed characteristic:

     $I_{BIAS} \approx$ 27.5mA for which $I_{BIASMON} \approx$ 573µA

     $I_{MOD} \approx$ 8.3mA for which $I_{MODMON} \approx$ 259µA

9) Restore the original settings of Table 2. Vary R27 and/or R28, and observe that the monitor-diode currents satisfy the equations in step 4—always provided that the laser currents I_{BIAS} and I_{MOD} remain within their programmed upper bounds, and also that the chip output voltages remain within compliance range. Try reducing the upper bounds (set by R25 and R26) on I_{BIAS} and I_{MOD}, and observe that the warning flag sets when the bounds fall below the required values. Try different laser characteristics and different V_{CC} supply voltages.

10) Observe that mark-density compensation is automatic. There is no sag in the monitor-diode current, even for data that consists of a 2MHz (4Mbps) square wave that corresponds to groups of 600 consecutive identical digits at 2.5Gbps, alternately zero and 1.

Optical Evaluation

The optical part of the EV kit mimics what might be found in a typical optical-communications environment.

The laser is AC-coupled to the MAX3865, with series capacitors C59 and C60 and inductive pullups L53–L56. In this way, the voltage at the active and dummy modulation output pins can swing symmetrically above and below the V_{CC} supply. Outputs in excess of $2V_{P-P}$ are available before the instantaneous voltage at either output pin falls below the specified 1.8V minimum, even when V_{CC} is as small as 3.3V nominal and the laser drop is as large as 2.0V. However, this arrangement must not be used with V_{CC} = 5V nominal, or the absolute maximum voltage ratings of MAX3865 are exceeded.

The MAX3865 EV kit does not include a laser-plus-monitor-diode combination; this must be provided by the user. Available laser/monitor combinations have a variety of pinouts; the kit makes provision for mounting almost all of these (Figure 2).

V_{CC} should be 3.3V nominal. As supplied, the EV kit has L58 short circuit, R62 open circuit, and C61 open circuit. If L58 is to be included, a V_{CC} connection to L53 must be cut, either by cutting a PC board trace or drilling out a via:

1) If the data is to be latched, open circuit JU51 to enable clock input; otherwise, leave JU51 in short circuit.
2) Set the mode of operation to manual by open circuit JU52, and short circuit JU53.
3) Adjust R65, R66, R67, and R68 to the full counter-clockwise position. This sets the modulation and bias currents to their minimum value.
4) Apply a differential input signal ($250mV_{P-P}$ per side) to J51 and J52 (DATA+ and DATA-).
5) If the latch is enabled, apply a differential clock signal ($250mV_{P-P}$ per side) to J53 and J54 (CLK+ and CLK-).

6) The EV kit is designed to allow connection of a variety of laser/monitor diode pin configurations. Connect a TO-header-style laser with monitor diode (Figure 2) as follows:

   a) Keeping the module leads as short as possible, connect the laser-diode cathode to the center pad on the component side of the circuit board. The anode is then connected to one of the two remaining component-side V_{CC} pads. The monitor diodes leads solder to the bottom of the circuit board.

   b) The monitor photodiode pads are arranged in a series of five pads on the bottom (solder side) of the PC board. The photodiode anode goes to one of three pads that are separated by two V_{CC} pads. The MD pin may be connected to the anode by a solder bridge. Connect the photodiode cathode to V_{CC} by bridging the cathode pad to the adjacent V_{CC} pad.

7) Power up the board with a V_{CC} of 3.3V.

8) Adjust R65 clockwise until the desired maximum bias current is achieved. The maximum current should be above threshold by an amount greater than any change in current expected with temperature and age.

   Attach a voltmeter between V_{CC} at TP54 and TP52 to monitor the bias current:

$$I_{BIAS} = \frac{48 \times V_{BIASMON}}{200}$$

9) Adjust R66 clockwise for the desired maximum modulation current. The maximum modulation current should be large enough to allow for any change in current required to maintain constant power with temperature and age. Attach a voltmeter between V_{CC} at TP54 and TP53 to monitor the modulation current:

$$I_{MOD} = \frac{32 \times V_{MODMON}}{200}$$

   Be careful not to fall below the compliance voltage of the modulation output as given by:

$$V_{CC} - \frac{I_{MOD}}{2} \times 25 \geq 1.8V$$

10) Remove JU53 to enable feedback control of the bias and modulation currents.

11) Adjust R67 clockwise to set the bias current to a value less than $I_{BIASMAX}$, which was set previously in step 8. The bias current can be monitored with a voltmeter as before.

12) Adjust R68 clockwise to set the modulation current to a value less than I_{MODMAX}, which was set previously in step 9. The modulation current can be monitored with a voltmeter as before.

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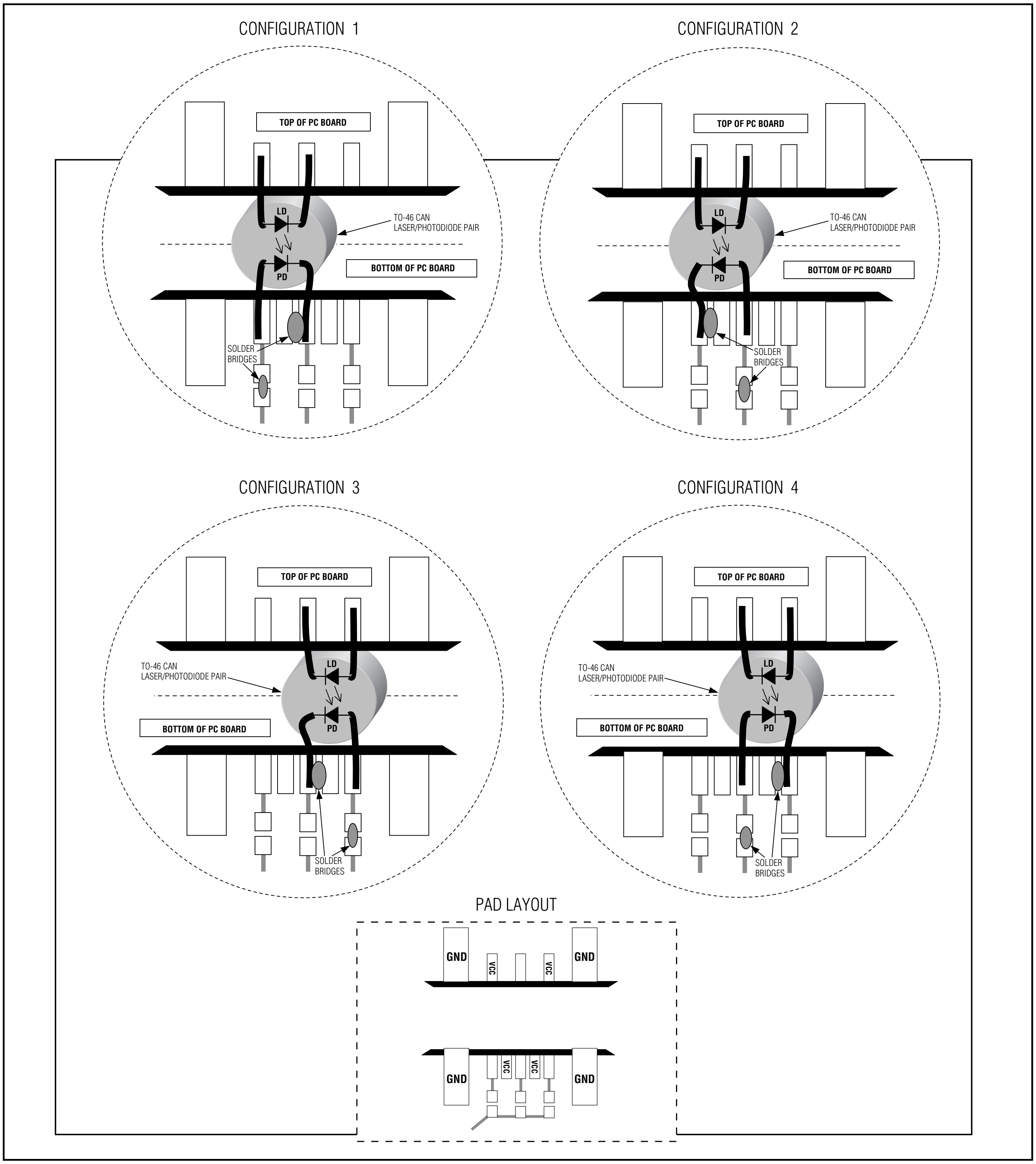

Figure 2. Attachment of a Laser Diode/Monitor Diode to the MAX3865 EV Kit

Adjustment and Control Descriptions*

COMPONENT				NAME	FUNCTION
ELECTRICAL		OPTICAL			
JU11		JU51		RETIMING ENABLE	Enables/disables data retiming. Shunt to disable data retiming. Open for direct data transmission.
JU12	JU13	JU52	JU53	MODE SELECT	—
Short	Short	Short	Short	Shutdown	Bias and modulation current off
Open	Short	Open	Short	Manual	MODMAX and BIASMAX control current directly
Short	Open	Short	Open	APC	APCSET controls bias current for constant average power
Open	Open	Open	Open	AMC	AMCSET and APCSET control currents for constant power and extinction ratio
JU14, JU15		NA		MD GAIN SETTING	Short to simulate laser to monitor diode current gains other than 0.01
JU16		JU56		MD SHUNT	Open if laser-to-monitor diode current gain < 0.005
JU17		NA		ALTERNATE V_{CC}	Open to bias the synthetic laser at a voltage other than V_{CC}
R25		R65		BIASMAX	Adjusts maximum bias current set point
R26		R66		MODMAX	Adjusts maximum modulation current set point
R27		R67		APC SET POINT	Adjusts average MD current set point
R28		R68		AMC SET POINT	Adjusts peak-to-peak MD current set point
TP1, TP14		TP2, TP54		V_{CC}	Supply voltage
TP4		TP3		GND	Ground reference
TP12		TP52		BIAS MONITOR	Monitor bias current
TP13		TP53		MOD MONITOR	Monitor modulation current
TP16		NA		MD MONITOR	Monitor synthetic photo-diode current
TP17		NA		ALTERNATE V_{CC}	Attachment for alternate bias to the synthetic laser

**See Quick Start first.*

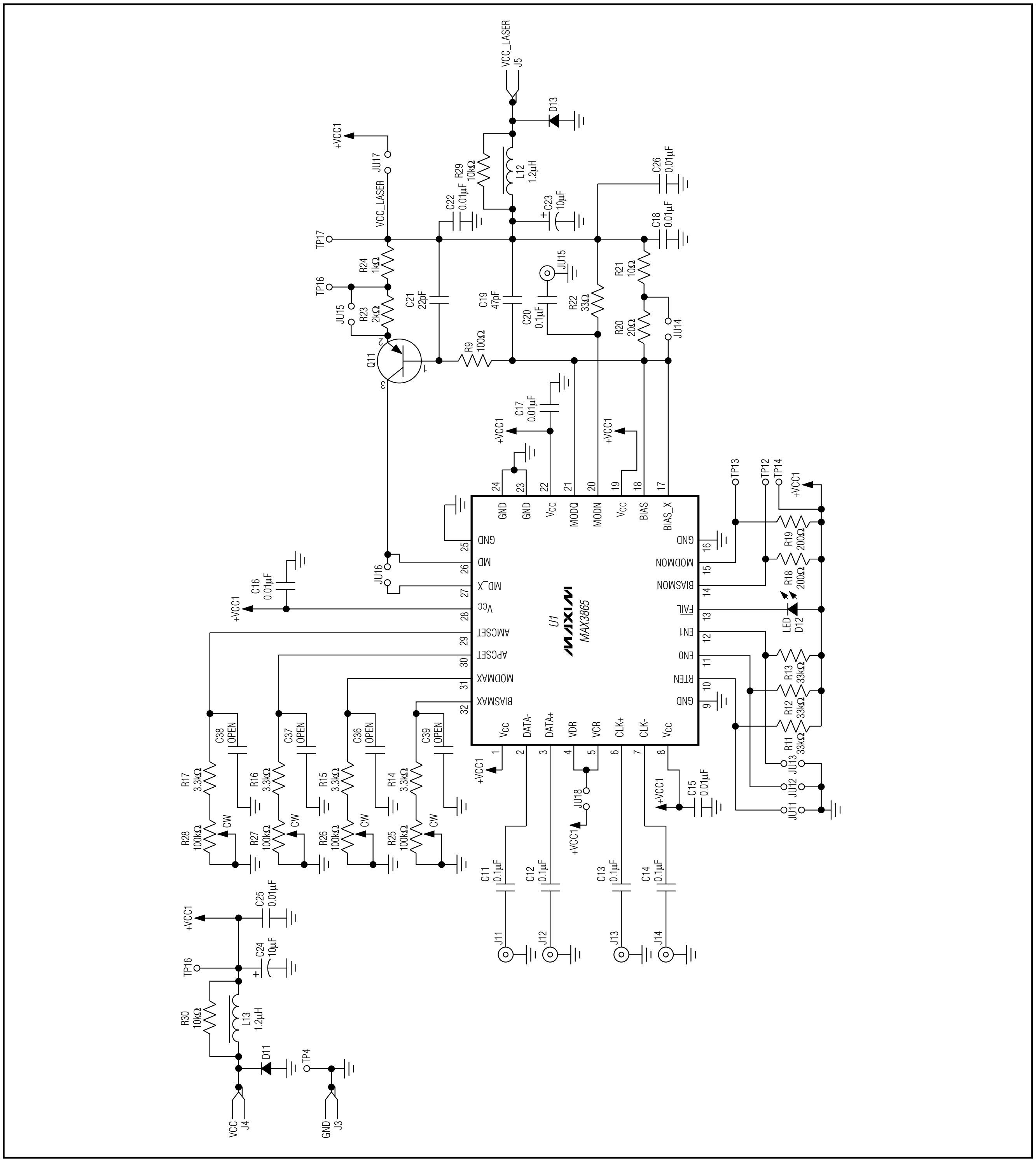

Figure 3. MAX3865 EV Kit Electrical Board Schematic

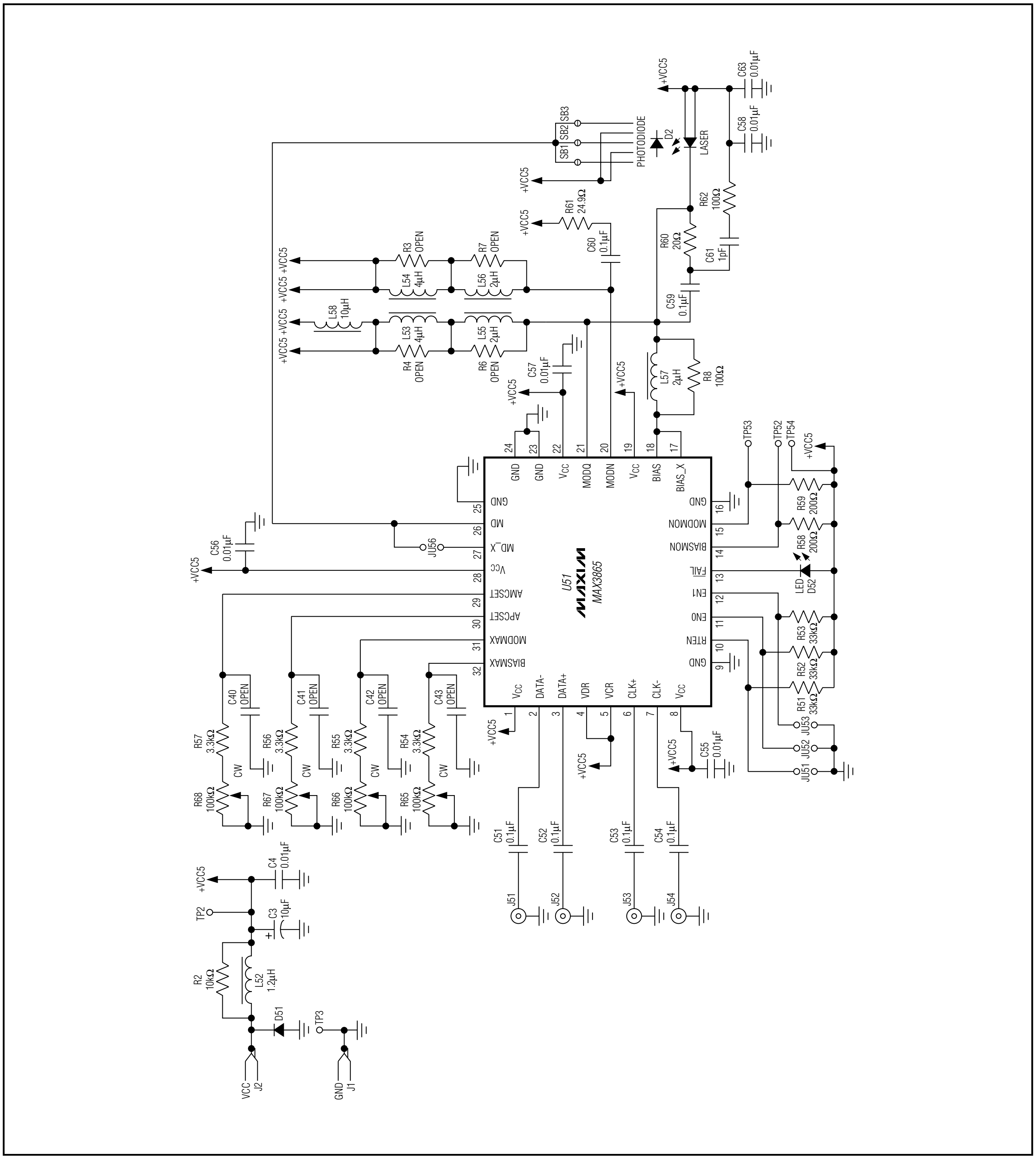

Figure 4. MAX3865 EV Kit Optical Board Schematic

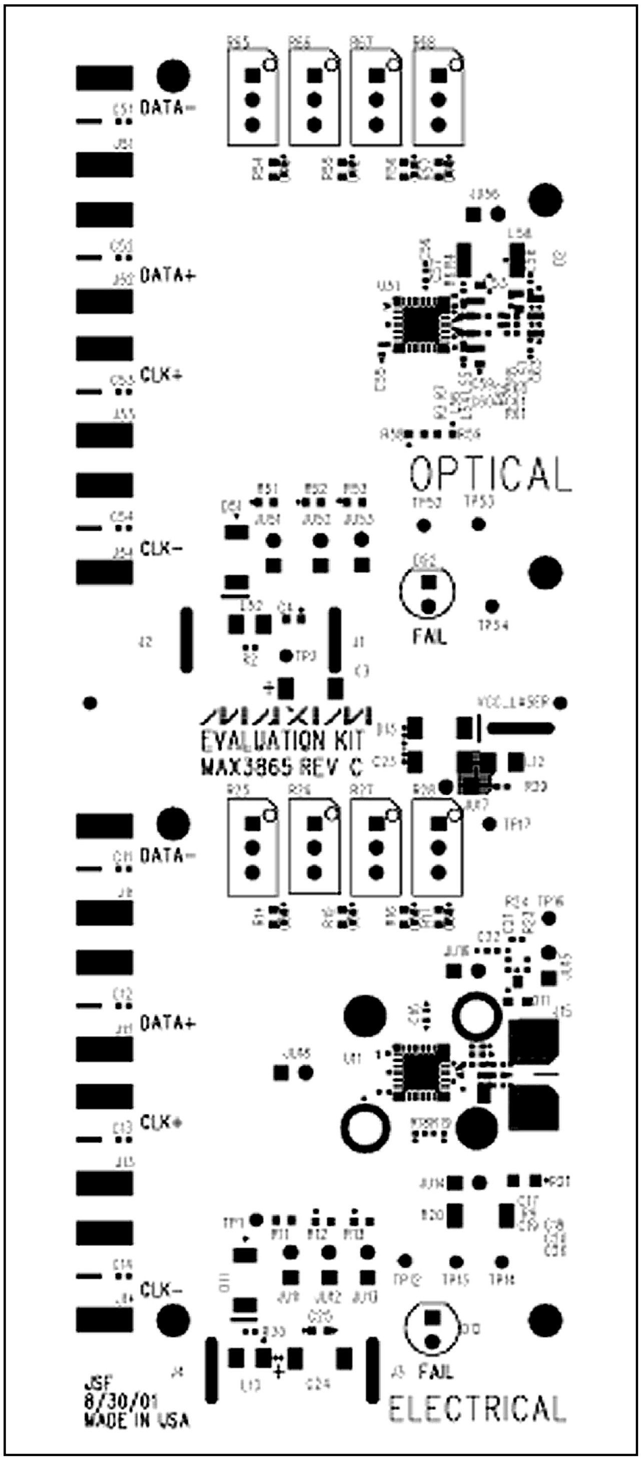

Figure 5. MAX3865 EV Kit Component Placement Guide—Component Side

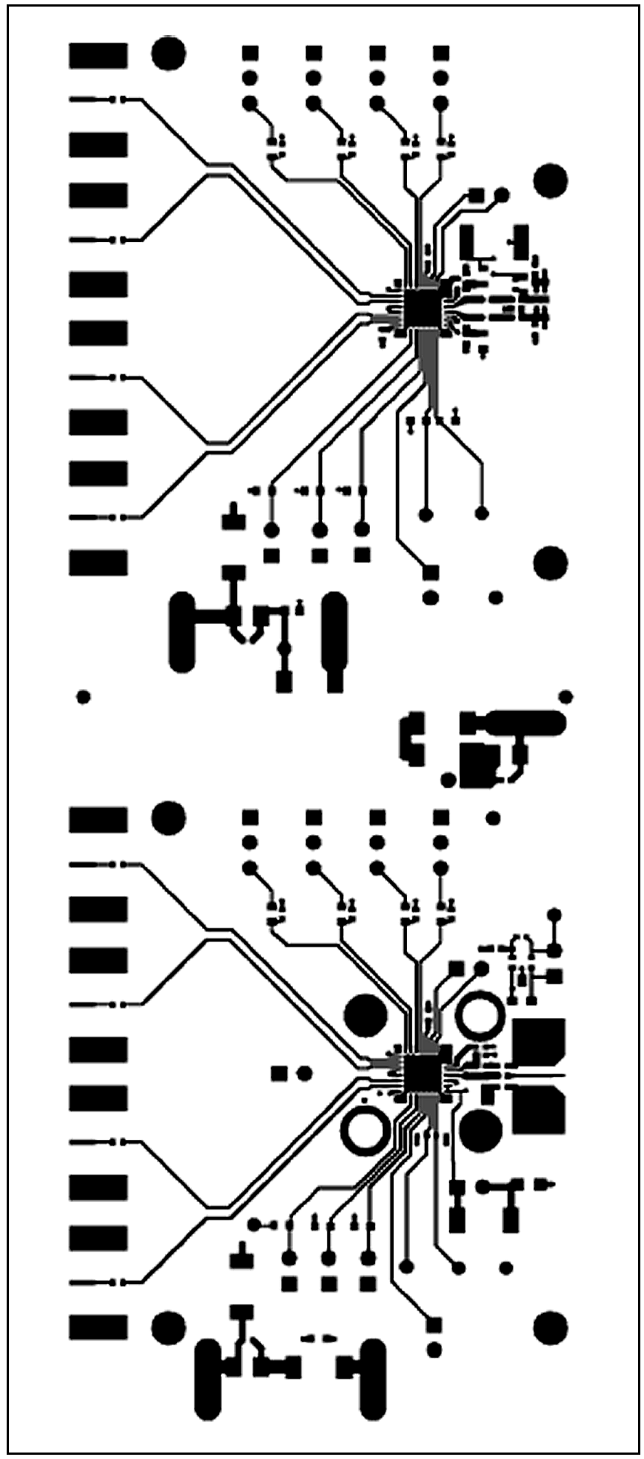

Figure 6. MAX3865 EV Kit PC Board Layout—Component Side

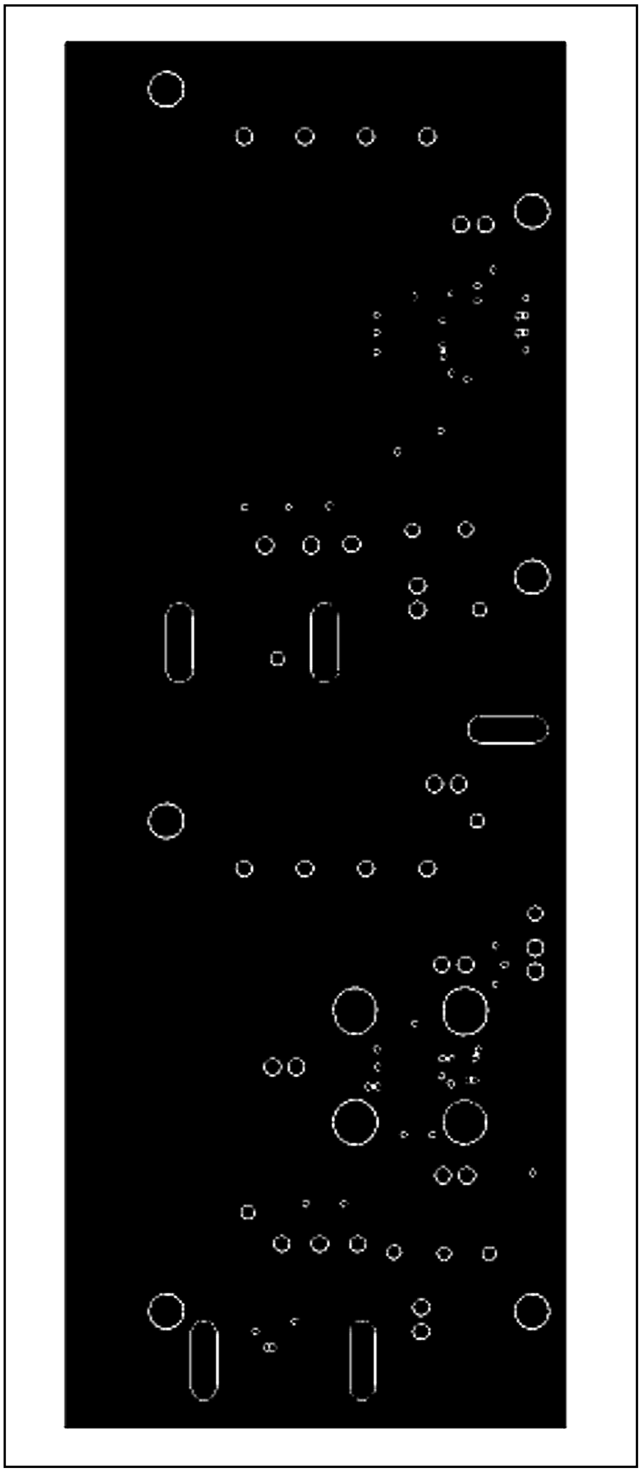

Figure 7. MAX3865 EV Kit PC Board Layout—Ground Plane

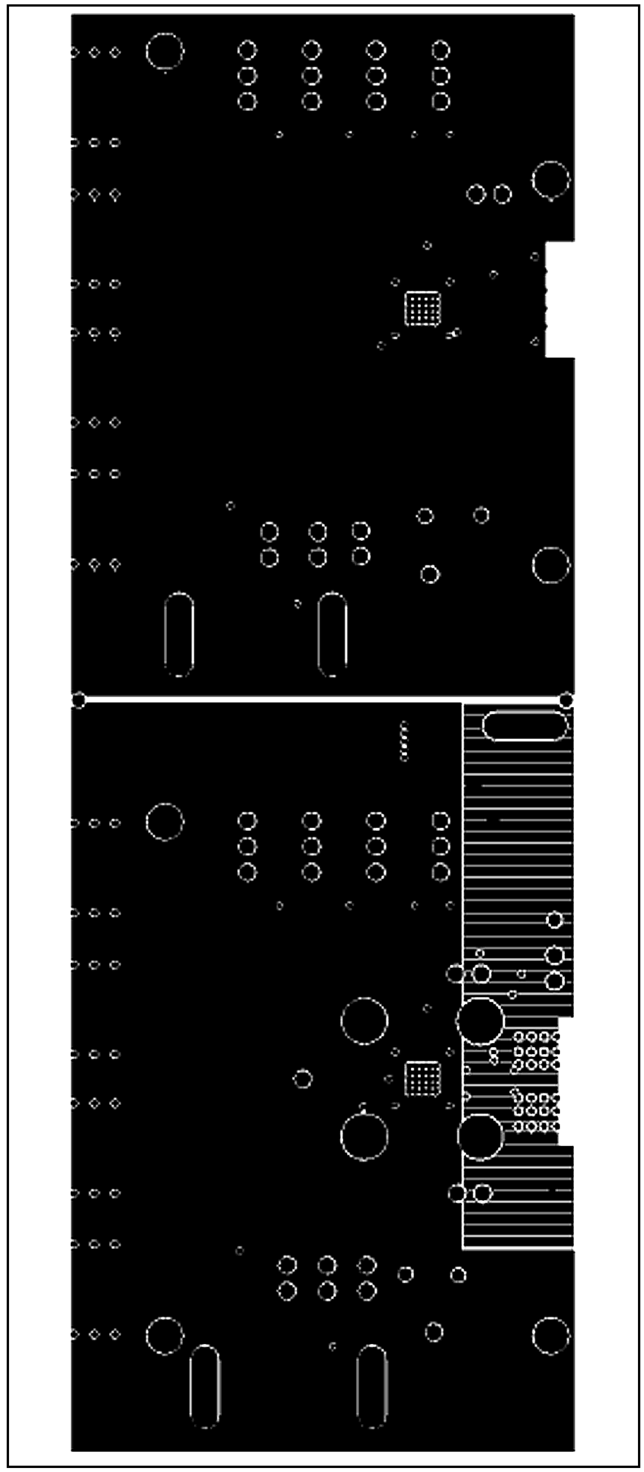

Figure 8. MAX3865 EV Kit PC Board Layout—Power Plane

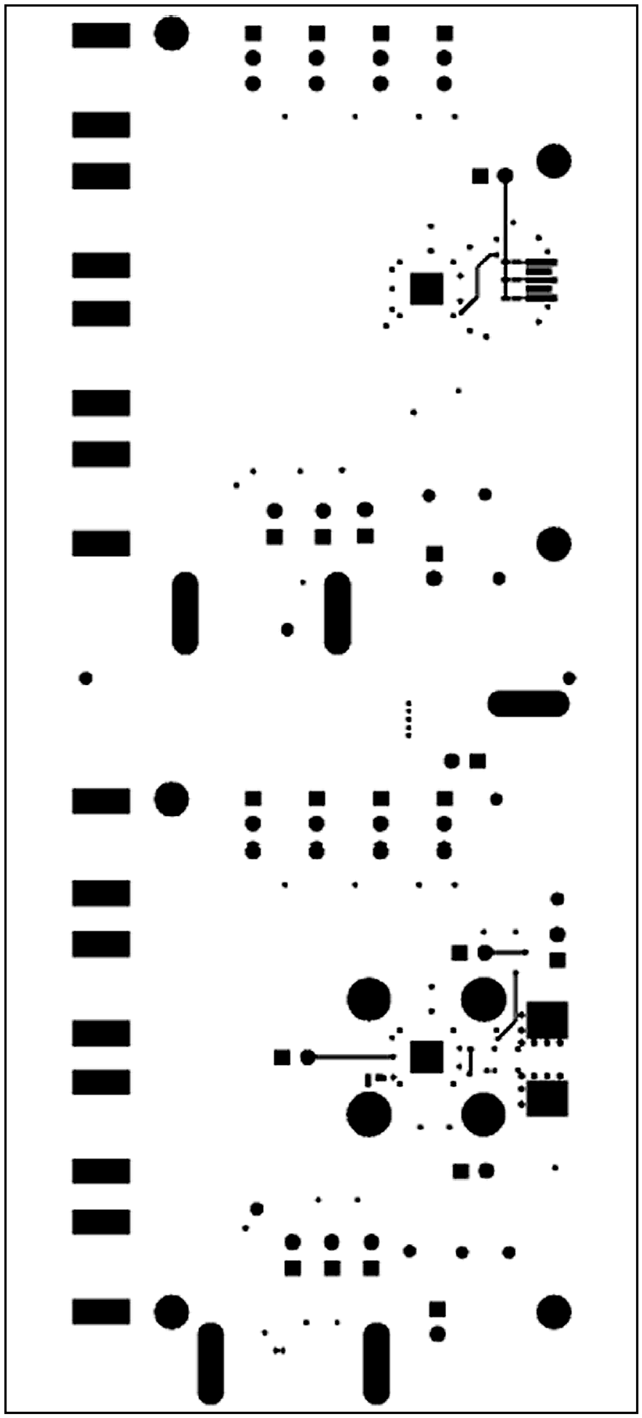

Figure 9. MAX3865 EV Kit PC Board Layout—Solder Side