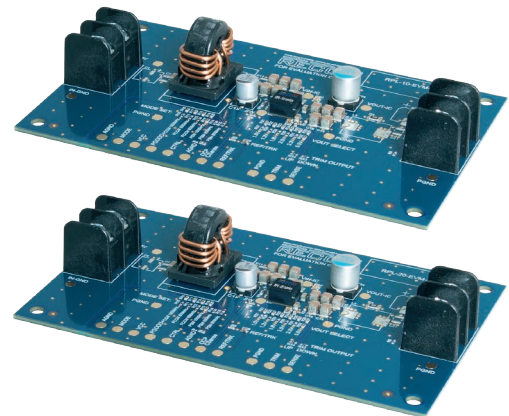


### FEATURES

- Evaluation platform for RPL-10(20) Buck Regulator Module
- Thermal design considerations included
- EMI Class B filter
- Easy evaluation of output voltage selection, control and sensing functions



### DESCRIPTION


The RPL-10/20-EVM-1 generates a constant output voltage selectable from 1.0V, 1.2V, 1.8V, 2.5V, 3.3V and 5V from a DC input in the range of 2.7 – 16V. It has a maximum continuous output current of 10A/15A\*. Switching frequency can be set from 600kHz, 800kHz and 1000kHz in PSM mode or FCCM mode. (\*For load see the derating graph of RPL10/20 module). All the functions of the RPL-10/20 such as output voltage selection, mode/frequency selection, control, power good, Soft start time, Over current protection (OCP), Under voltage lockout (UVLO), trim and output sense can be readily evaluated. Also the behavior in overload or over-temperature can be evaluated easily before it is designed in. The evaluation board also contains the filter components to meet EMC Class B levels. Alternate component positions are included to allow experimentation to optimize the EMC performance depending on operating conditions and budget.

### SELECTION GUIDE

Part Number	Input Voltage Range [VDC]	Output Voltage [VDC]	Output Current max. [mA]	Switching Frequency [kHz]
RPL-10-EVM-1	4-16	1.0, 1.2, 1.8, 2.5, 3.3, 5.0	10000	600, 800, 1000
RPL-20-EVM-1	4-16	1.0, 1.2, 1.8, 2.5, 3.3, 5.0	20000	600, 800, 1000

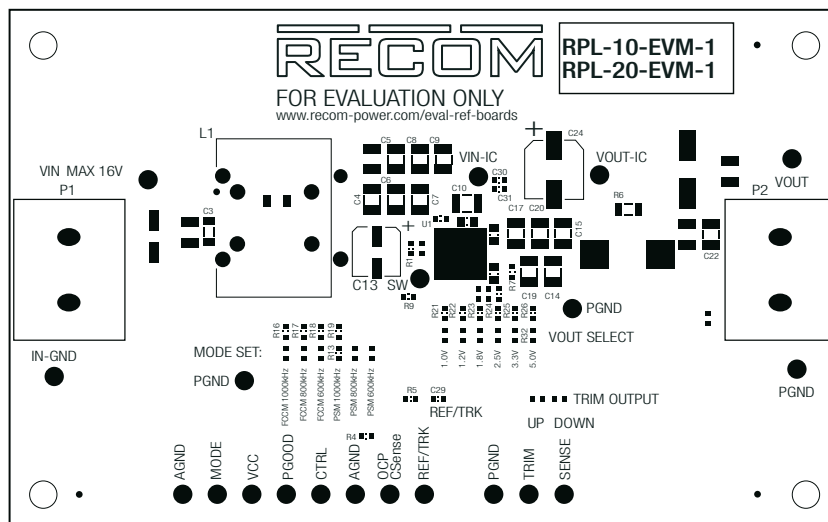
#### Quick Start Guide:

1. Connect P1 to power supply (observe correct polarity!)
2. Connect P2 to the load (no load operation is allowed).
3. The evaluation module is preset to 5Vout.
4. The output voltage can be selected with values of 1.0V, 1.2V, 1.8V, 2.5V, 3.3V and 5V by shorting a 0Ω resistor to the respective places as seen in the board silkscreen.
5. UVLO. The circuitry implements internal UVLO on the VIN pin. The device is disabled when Internal voltage falls under 1.22V (TYP.). When higher UVLO threshold is required assemble resistor R2. For the values refer to the RPL-10/20 datasheet.
6. CTRL. The device is preset as normally on. It can be disabled by pulling the CTRL pad to GND. Short R2 to disable the device.
7. The device switching frequency and mode is set to default value PSM 1000kHz. This can be changed by shorting 0Ω resistor to the respective places as seen in board silkscreen. For the values and safe operating area refer to the RPL-10/20 datasheet.



**Caution:**  
ESD sensitive. Always follow ESD preventative procedures when handling the product!

### COMPONENT PLACEMENT



### Connector Description

Pads direct connection

Name	Description
VIN	Positive Input Voltage
IN-GND	Negative Input Voltage (IN-GND)
CTRL	CTRL Pad (leave open if not used) or UVLO setting
MODE	Pad for setting mode & frequency
VCC	Internal 3V LDO Output
PGOOD	Power Good Signal
GND	Main Power GND (GND)
AGND	Analog GND (AGND)
REF/TRK	External Tracking Voltage Input
OCP CSense	Pad for setting current limit trip point
SENSE	Output Voltage Sense Pin (leave open if not used)
TRIM	TRIM Pad (leave open if not used)
VOUT	Positive Output Voltage
GND	Negative Output Voltage (GND)

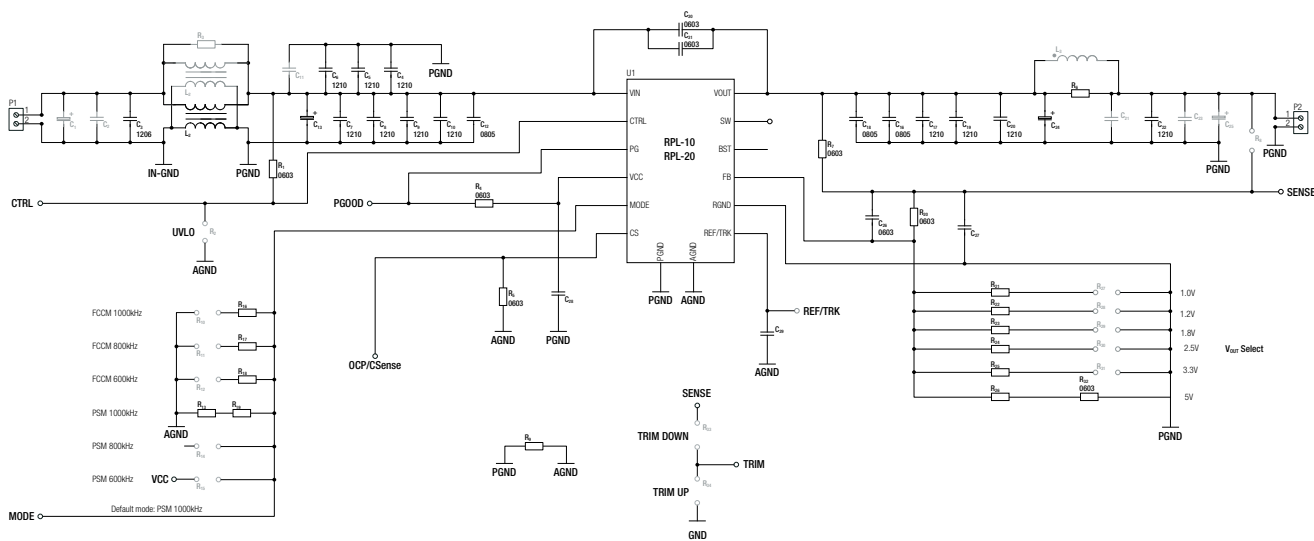
P1

Pin	Name	Description
1	VIN	Positive Input Voltage (observe correct polarity!)
2	GND	Common GND

P2

Pin	Name	Description
1	VOUT	Positive Output Voltage
2	GND	Main Power GND

### SCHEMATIC



Note1: Gray colored components are not mounted.

### DESCRIPTION

U1: RPL-10/20 power module.

C1-C13, L1, L2, R3: allow placement of various sized components to test input filter design. The populated filter is designed to meet EN55022 class B.

C14-C25, L3, R6: allow placement of various sized components to test output filter design. The populated filter is designed to meet EN55022 class B.

R1, R2: configure CTRL and UVLO. R1 is populated to enable the RPL-10 - Short R2 in order to disable the RPL-10 or populate R2 in order to set UVLO threshold. Refer to „Under Voltage Lockout“

MODE&FREQUENCY Selection: Switching frequency can be selected with resistor connected to MODE input of U1. Position R10-R15 is for user defined switching frequency. (Refer to „Mode & Switching Frequency Settings“)

R5: This resistor determines the current limit trip point. Refer to „Current Limit“

C29: This capacitor defines the soft-start time cca 2ms. Refer to „Soft Start Time“ and „External Tracking Voltage“

R7: populated zero ohm resistor for direct output voltage measurement. If sense is desired at a different location, for example after the filter or directly at the load), unsolder R7, and connect sense to the new measurement point.

R8: sense point for output voltage after the filter. To set sense point here, remove R7 and solder a zero ohm resistor at R8.

VOUT Selection R27-R32: the output voltage can be selected with values of 1.0V, 1.2V, 1.8V, 2.5V, 3.3V and 5V by shorting a zero ohm resistor to the respective places as seen in the board silkscreen.

R33, R34: trim the output voltage. Refer to „Output Voltage Trimming“

### UNDER VOLTAGE LOCKOUT

The RPL-10/20 provides accurate CTRL thresholds to allow a resistor divider placed between VIN and AGND to be used to configure VIN at the point when the RPL-10/20 is enabled. The resistor divider values (VIN\_START) can be calculated using Equation:

$$V_{IN\_START} = V_{EN\_RISING} \times \frac{(R_1 + R_2)}{R_2}$$

Where VEN\_RISING is the EN input rising threshold (typically 1.22V), R1 is the pull-up resistor, and R2 is the pull-down resistor.

### MODE & SWITCHING FREQUENCY SETTINGS

Select the operation for light-load conditions and fSW by placing the 00hm resistor on one of the positions R10-R15.

### CURRENT LIMIT

The RPL-10/20 features on-die current sensing and a configurable over-current protection (OCP) threshold for the inductor valley current. However, the conversion between the inductor valley current and IOUT may involve error that is introduced by the tolerance of the integrated inductor and fSW variation due to COT operation.

The RPL-10 integrates an 10kΩ current-sense resistor RCS between CS and AGND.

The RPL-20 integrates a 24.9kΩ current-sense resistor RCS between the CS and AGND pins.

R5 for the desired IOUT limit (ILIM) can be calculated using Equation:

$$R5(M\Omega) || R_{CS} = \frac{V_{LIM}}{G_{CS} \times \left( I_{LIM}(A) - \frac{(V_{IN} - V_{OUT}) \times V_{OUT}}{V_{IN}} \times \frac{1}{2 \times L(\mu H) \times f_{SW}(MHz)} \right)}$$

Where VLIM = 1.2V, GCS = 20μA/A, and L = 0.68μH, for RPL-10

Where VLIM = 1.2V, GCS = 10μA/A, L = 0.15μH, for RPL-20.

### SOFT START TIME

With the integrated, 100nF, soft-start (SS) capacitor, the minimum SS time (tSS) is limited to 1.6ms. tSS can be increased by adding an external capacitor between TRK/REF and AGND.

CSS can be calculated using Equation:

$$C_{SS}(nF) = \frac{(t_{ss}(ms) \times 36\mu A)}{0.6V} - 100nF$$

### EXTERNAL TRACKING VOLTAGE

The RPL10/20 provides TRK/REF, an analog input pin, to track another power supply or accept an external reference. When an external voltage signal is connected to TRK/REF, it acts as a reference for the RPL10/20 VOUT. VFB follows this external voltage signal exactly, and the SS settings are ignored. The TRK/REF input signal can be in the 0.3V to 1.4V range. During initial start-up, TRK/REF must first reach or exceed 600mV to ensure proper operation. Afterward, TRK/REF can be any value between 0.3V and 1.4V.

### OUTPUT VOLTAGE TRIMMING

The RPL-10/20-EVM-1 offers the feature of trimming the output voltage in range 0.6 to 5.5V by using external trim resistors. Recommended value of RH (R20) is 11kΩ so margin of trimming down is limited. The values for trim resistors are shown in trim tables below according to E96 values; therefore, the specified voltage may slightly vary. Refer to „**Selection Guide**“ for applicable Vout range.

**Calculation:**

- V<sub>OUT</sub> = nom. output voltage [VDC]
- V<sub>out<sub>set</sub></sub> = trimmed output voltage [VDC]
- R<sub>up</sub> = trim up resistor [Ω]
- R<sub>down</sub> = trim down resistor [Ω]
- R<sub>H</sub>, R<sub>L</sub> = feedback resistors [Ω]

V <sub>OUT</sub> [VDC]	R <sub>H</sub> [Ω]	R <sub>L</sub> [Ω]
1.0	11	16k5
1.2		11k
1.8		5k49
2.5		3k48
3.3		2k4
5.0		1k5

$$R_{up} = \frac{R_H R_L V_{out}}{(V_{set} - V_{out})(R_H + R_L)} = [k\Omega]$$

$$R_{down} = \frac{V_{set} R_H^2 - R_H R_L (V_{out} - V_{set})}{(V_{out} - V_{set})(R_H + R_L)} = [k\Omega]$$

**Practical Example RPL-10(20), trim up:**

V<sub>OUT</sub>= 3.3VDC, V<sub>out<sub>set</sub></sub>= 3.7VDC

$$R_{up} = \frac{2.4 \times 11 \times 3.3}{(3.7 - 3.3)(11 + 2.4)} = \mathbf{6.254k\Omega}$$

R<sub>up</sub> = **16.2kΩ** (according to E96 1%)

**Practical Example RPL-10(20), trim down:**

V<sub>OUT</sub>= 3.3VDC, V<sub>out<sub>set</sub></sub>= 3.1VDC

$$R_{down} = \frac{3.1 \times 11^2 - 11 \times 2.4(3.3 - 3.1)}{(3.3 - 3.1)(11 + 2.4)} = \mathbf{137.993k\Omega}$$

R<sub>down</sub> = **137kΩ** (according to E96 1%)

**V<sub>out<sub>set</sub></sub>= 1.0VDC**

**Trim up**

V <sub>out<sub>set</sub></sub> =	1.1	[VDC]
R <sub>up</sub> (E96) ≈	66k5	[Ω]

**Trim down**

V <sub>out<sub>set</sub></sub> =	0.9	0.8	0.7	0.6	[VDC]
R <sub>down</sub> (E96) ≈	33k2	11k	3k57	0	[Ω]

**V<sub>out<sub>set</sub></sub>= 1.2VDC**

**Trim up**

V <sub>out<sub>set</sub></sub> =	1.4	1.5	1.6	[VDC]
R <sub>up</sub> (E96) ≈	33k2	22k1	16k2	[Ω]

**Trim down**

V <sub>out<sub>set</sub></sub> =	1.1	[VDC]
R <sub>down</sub> (E96) ≈	54k9	[Ω]

**V<sub>out<sub>set</sub></sub>= 1.8VDC**

**Trim up**

V <sub>out<sub>set</sub></sub> =	1.9	2	2.1	[VDC]
R <sub>up</sub> (E96) ≈	66k5	33k2	22k1	[Ω]

**Trim down**

V <sub>out<sub>set</sub></sub> =	1.6	1.5	1.4	[VDC]
R <sub>down</sub> (E96) ≈	54k9	33k2	22k1	[Ω]

**V<sub>out<sub>set</sub></sub>= 2.5VDC**

**Trim up**

V <sub>out<sub>set</sub></sub> =	2.7	2.9	3.0	[VDC]
R <sub>up</sub> (E96) ≈	33k2	16k5	1k33	[Ω]

**Trim down**

V <sub>out<sub>set</sub></sub> =	2.4	2.3	2.2	[VDC]
R <sub>down</sub> (E96) ≈	200k	93k1	59k	[Ω]

**V<sub>out<sub>set</sub></sub>= 3.3VDC**

**Trim up**

V <sub>out<sub>set</sub></sub> =	3.5	3.7	3.8	4.0	[VDC]
R <sub>up</sub> (E96) ≈	32k4	16k2	13k	9k31	[Ω]

**Trim down**

V <sub>out<sub>set</sub></sub> =	3.2	3.1	3.0	[VDC]
R <sub>down</sub> (E96) ≈	287k	137k	88k7	[Ω]

**V<sub>out<sub>set</sub></sub>= 5.0VDC**

**Trim up**

V <sub>out<sub>set</sub></sub> =	5.1	5.2	5.3	5.5	[VDC]
R <sub>up</sub> (E96) ≈	66k5	33k2	22k1	13k3	[Ω]

**Trim down**

V <sub>out<sub>set</sub></sub> =	4.8	4.5	4.2	4.0	[VDC]
R <sub>down</sub> (E96) ≈	232k	86k6	49k9	37k4	[Ω]

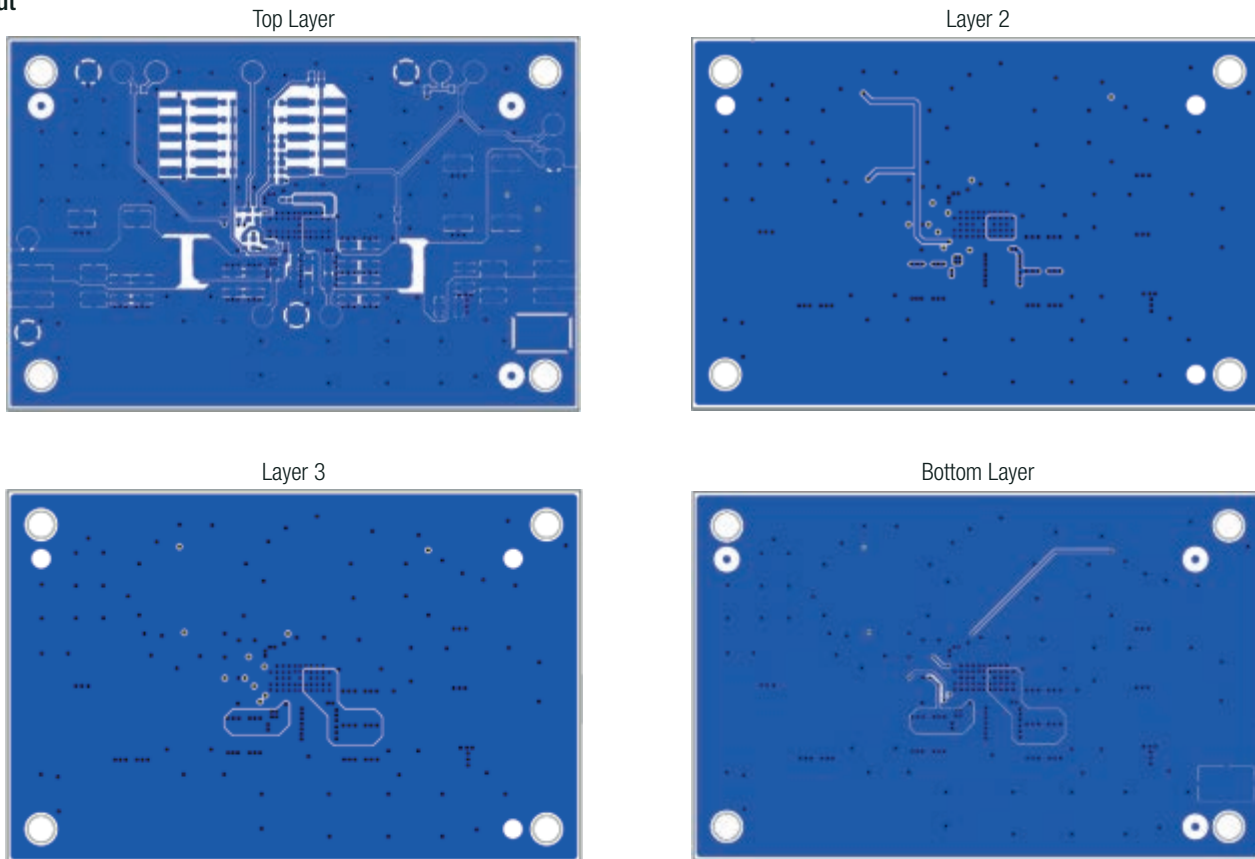
# RPL-10(20)-EVM-1 ◊ Evaluation Module

10(20)Amp ◊ Input: 4-16VDC

## DIMENSION & PHYSICAL CHARACTERISTICS

Parameter	Type	Value
Dimension (LxWxH)		120.0 x 75.0 x 25.0mm 0.86 x 0.36 x 0.44inch
Weight		76g typ. 0.17 lbs

### Layout



Note2: Visit [www.recom-power.com/eval-ref-boards](http://www.recom-power.com/eval-ref-boards) to download Gerber files

## BOM

Component	Description	Manufacturer Part Number	Manufacturer	Remarks
C1	ECAP 6.6x6.6			not mounted
C2, C11, C21, C23	CAP 1210			not mounted
C3	10µF 25V X7R 1206	CL31B106KAHNNE	SAMSUNG ELECTRO-MECHANICS	
C4-C10	10µF 25V X7R 1210	CL32B226KAJNFNE	SAMSUNG ELECTRO-MECHANICS	
C12	4.7µF 25V X7R 0805	CL21B475KAFNNG	SAMSUNG ELECTRO-MECHANICS	
C13	100µF 25V 6.3x6.3	EEE-FK1E101XP	PANASONIC	
C14-C20, C22	22µF 16V X7R 1210	CL32B226K0JNNNE	SAMSUNG ELECTRO-MECHANICS	
C24	560µF 16V 8.5x8.5	APXG160ARA561MHA0G	NIPPON CHEMI-CON	
C25	ECAP 8.5x8.5			not mounted
RPL-10 C26	4.7nF 50V X7R 0603	C0603C472K5RACTU	KEMET	
RPL-20 C26	1nF 50V X7R 0603	CL10C102JB8NNNC	SAMSUNG ELECTRO-MECHANICS	
C27, C28	1µF 16V X7R 0603	CL10B105K08NFNC	SAMSUNG ELECTRO-MECHANICS	
C29	22nF 100V X7R 0603	CC0603KRX7R0BB223	YAGEO	
RPL-10 C30	470pF 100V X7R 0603	CL10B471KB8NNNC	SAMSUNG ELECTRO-MECHANICS	
RPL-20 C30	4.7nF 50V X7R 0603	C0603C472K5RACTU	KEMET	
C31	4.7nF 50V X7R 0603	C0603C472K5RACTU	KEMET	
L1	CMC 1mH 15A	7448031501	WURTH	
L2	CMC SCF19XV			not mounted

# RPL-10(20)-EVM-1 ◊ Evaluation Module

10(20)Amp ◊ Input: 4-16VDC

BOM				
Component	Description	Manufacturer Part Number	Manufacturer	Remarks
L3	FERRITE BEAD			not mounted
P1, P2	CONNECTOR	38720-7502	MOLEX	
R1	390kΩ 0.1W 0603	RC0603FR-07390KL	YAGEO	
R2, R3	RES 0603			not mounted
R4	10kΩ 0.1W 0603	RC0603FR-0710KL	YAGEO	
RPL-10 R5	10kΩ 0.1W 0603	RC0603FR-0710KL	YAGEO	
RPL-20 R5	7.5kΩ 0.1W 0603	RC0603FR-077K5L	YAGEO	
R6	0Ω 0.5W 1206	JR1206X40E	OHMITE	
R7, R9, R13, R18, R32	0Ω 0.1W 0603	RC0603JR-070RL	YAGEO	
R8, R10-R12, R14, R15, R27-R31, R33, R34	RES 0603			not mounted
R16	82.5kΩ 0.1W 0603	RC0603FR-0782K5L	YAGEO	
R17	34.8kΩ 0.1W 0603	RC0603FR-0734K8L	YAGEO	
R19	249kΩ 0.1W 0603	RC0603FR-07249KL	YAGEO	
R20, R22	11kΩ 0.1W 0603	RC0603FR-0711KL	YAGEO	
R21	16.5kΩ 0.1W 0603	RC0603FR-0716K5L	YAGEO	
R23	5.49kΩ 0.1W 0603	RC0603FR-075K49L	YAGEO	
R24	3.48kΩ 0.1W 0603	RC0603FR-073K48L	YAGEO	
R25	2.4kΩ 0.1W 0603	RC0603FR-072K4L	YAGEO	
R26	1.5kΩ 0.1W 0603	RC0603FR-071K5L	YAGEO	
RPL-10 U1	RPL-10 MODULE	RPL-10	RECOM	
RPL-20 U1	RPL-20 MODULE	RPL-20	RECOM	

PACKAGING INFORMATION		
Parameter	Type	Value
Packaging Dimension (LxWxH)	single box	205.0 x 135.0 x 43.0mm
Packaging Quantity		1pc

## CONTENTS

- RPL-10-EVM-1/ RPL-20-EVM-1 Evaluation Module
- Terms and conditions

The product information and specifications may be subject to changes even without prior written notice. The product has been designed for various applications; its suitability lies in the responsibility of each customer. The products are not authorized for use in safety-critical applications without RECOM's explicit written consent. A safety-critical application is an application where a failure may reasonably be expected to endanger or cause loss of life, inflict bodily harm or damage property. The applicant shall indemnify and hold harmless RECOM, its affiliated companies and its representatives against any damage claims in connection with the unauthorized use of RECOM products in such safety-critical applications.