DRV10964 Evaluation Module User's Guide

This document is provided with the DRV10964 customer evaluation module (EVM) as a supplement to the DRV10964 datasheet (SLDS227). It details the hardware implementation of the EVM and gives a step-by-step introduction to the device operation.

Contents

1 DRV10964 EVM Kit Contents

The DRV10964 evaluation kit contains the DRV10964 EVM.

2 Introduction

The DRV10964 EVM is an evaluation platform for the DRV10964 three-phase brushless DC motor driver. The EVM includes a TLC555 timer configured to supply a PWM to the DRV10964 and potentiometer to adjust the speed of the motor by varying the duty cycle of the PWM.

This document describes the kit details and explains the functions and locations of test points, jumpers, and connectors present on the kit. For detailed information about the DRV10964, refer to the DRV10964 data sheet (SLDS227).

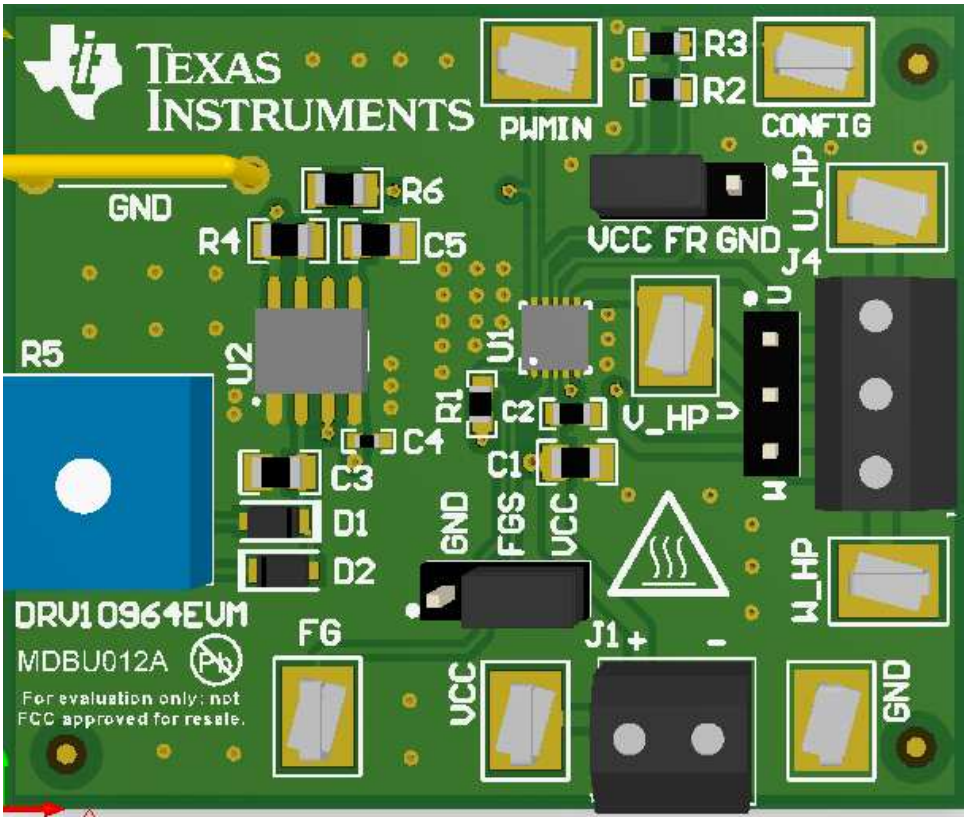


Figure 1. DRV10964 EVM

3 DRV10964 On-Board Connections

3.1 Power Input

The DRV10964 requires an external power supply (2.1 V to 5.5 V) to operate. Connector J1 provides the required interface for the external power supply. The pin assignment of terminal P1 is as follows:

Table 1. DRV10964

Pin	Description
1	VCC
2	GND

3.2 Interface Connectors (J4) for Phases of Motor

Connector J4 is used to interface the U, V, and W phases. The pin assignments are as follows:

Table 2. Connector P2: 3-Terminal Connector to Connect 3-Phase BLDC Motor

Pin	Description
1	Phase-W
2	Phase-V
3	Phase-U

3.3 TLC555 Pins

Table 3 lists the TLB555 pin descriptions.

Table 3. TLC555 Pins

Pin	Description
1	GND
2	TRIG
3	OUT
4	RESET
5	CONT
6	THRES
7	DISCH
8	VCC

4 DRV10964 Package

The DRV10964 pin-out is listed in Table 4.

Table 4. DRV10964 Pin-Out

Pin	Description
1	FG
2	FG_STATUS
3	VCC
4	W
5	GND
6	V
7	U
8	FR
9	CONFIG
10	PWM

The DRV10964 is packaged in a 10-pin USON package. For detailed information about the DRV10964, refer to the DRV10964 data sheet (SLDS227).

5 User Interface

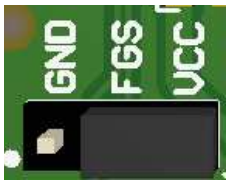
5.1 Jumpers

Descriptions for the jumpers are provided in the following list:

- **FR:** Motor direction selector. Upon start-up, the DRV10964 device spins the motor in the direction indicated by the FR input pin. The direction of commutation is as described in the following table.

Connection	Direction Description
VCC – FR	U → W → V
GND – FR	U → W → V

- **CMTMOD:** The FGS pin is used to configure the output of the FG pin. Based on the configuration of the FGS pin and the frequency of FG (FG_FREQ), the motor speed is calculated as shown in the following table.



Connection	Description
VCC – FR	RPM = (FG_FREQ × 60 ×3) / Number of pole pairs
GND – FGS	RPM = (FG_FREQ × 60) / Number of pole pairs

5.2 PWM Configuration With the TLC555 Timer

The PWM signal is generated with circuitry based on TI's TLC555 low-power timer. PWM is generated based on input from the potentiometer. The PWM signal generated by the circuitry on the EVM is approximately 25 kHz and is adjustable from 5% to 95% duty cycle using the potentiometer (**R5**). External PWM input can be applied to test point PWMIN by removing resistor R6.

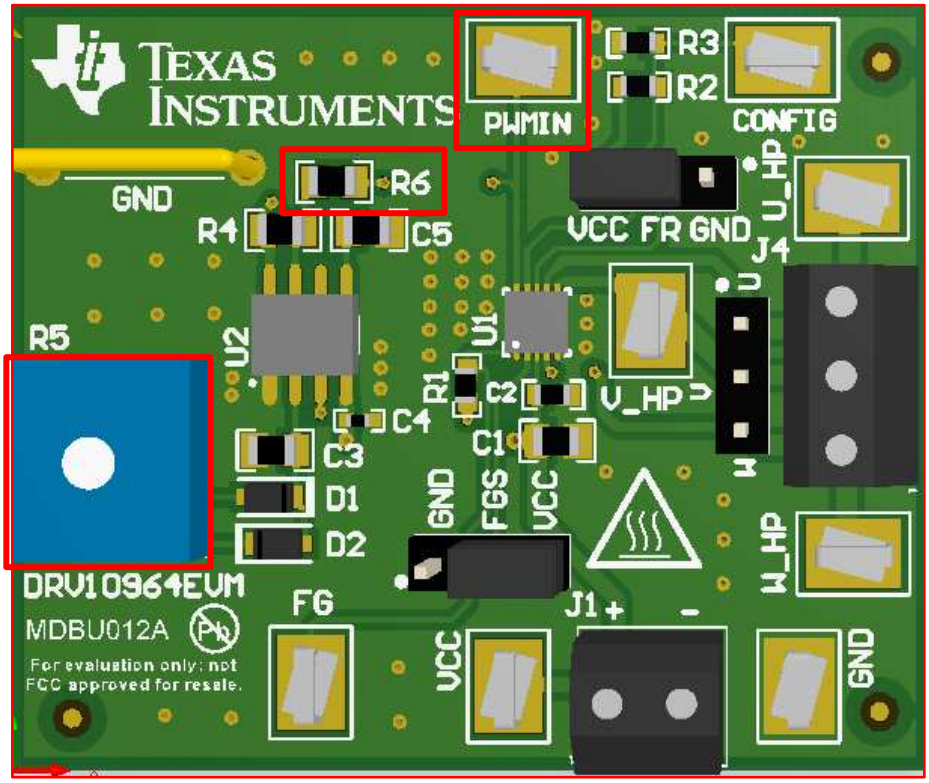


Figure 2. PWM Configuration for DRV10964 EVM

The potentiometer adjusts the duty cycle of the PWM signal, which in turn adjusts the speed of the motor. A lower duty cycle gives a lower speed and a higher duty cycle provides a higher speed. Turning the potentiometer counterclockwise lowers the speed, and turning it clockwise increases the speed.

For more information on the PWM input required by the DRV10964, refer to the datasheet (SLDS227).

5.3 Test Points

Test points are provided and labeled according to the inputs and outputs of the DRV10964 motor driver (see Table 5).

Table 5. Test Point Descriptions

Test Points	Description	Test Points	Description
TP 1	PWMIN	TP 5	Motor V phase
TP 2	GND	TP 6	VCC
TP 3	CONFIG	TP 7	FG
TP 4	Motor U phase	TP 8	Motor W phase

CAUTION

Do not apply power to the board before you have read Section 6!

6 Powering-Up the EVM

The DRV10964 EVM requires a VM power supply source, which has a recommended operating range from 2.1 to 5.5 V. Use the following sequence to power-up the EVM:

1. Connect the power supply Ground to pin 1 (GND) and a voltage between 2.1 to 5.5 V to pin 2 of connector P1 (VM). Set the current limit on the power supply to 1 A and make sure switch S1 is in the OFF position.
2. Turn the POT-R5 fully CCW (counterclockwise). This keeps the speed PWM input to the minimum value.
3. Connect the 3-phase terminal of the motor to connector J4 or U-V-W test points.
4. Power up the board by turning the power supply on.
5. Rotate the potentiometer to different positions to change the speed of motor.

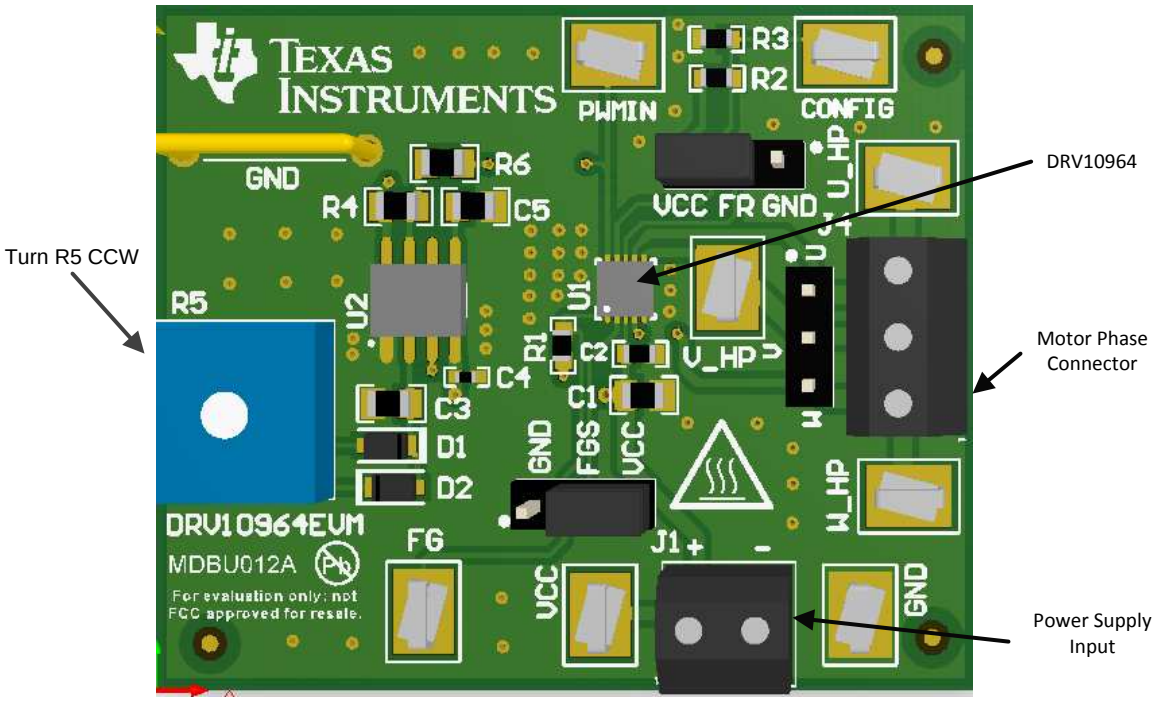


Figure 3. DRV10964 EVM With Various Connections and User Interface

7 Tune Open to Close Loop Handoff Threshold

The DRV10964 has the option of changing open to close loop handoff threshold by configuring the CONFIG pin. If there is an issue with the motor starting up, TI recommends changing the open to close loop handoff threshold. Different levels of open to close loop threshold can be set based on the voltage applied (percentage of supply voltage) on the CONFIG pin. The open to close loop handoff can be changed either by changing the voltage on the CONFIG testpoint or by changing biasing resistors R2 and R3. Table 6 shows the available options for open to close threshold and associated configuration.

Table 6. CONFIG Pin Configurations for Open to Close Loop Handoff Threshold

Config Pin (% V_{CC}) Ratio of (R3 / (R2 + R3))	Open to Close Handoff Threshold (Hz)	Config Pin Voltage for V_{CC} = 5 V	Suggested Resistance Value (1)	
			R3 (kΩ)	R2 (kΩ)
3.14	78	0.16	10.8989	356.72
9.4	12.5	0.47	10.8989	99.067
15.6	25	0.78	10.8989	54.985
21.8	37.5	1.09	10.8989	35.76
28.1	50	1.41	10.8989	26.782
34.4	62.5	1.72	10.8989	19.748
40.6	75	2.03	10.8989	15.601
46.8	87.5	2.34	10.8989	11.897
53.1	100	2.66	10.8989	9.8418

(1) Resistor value is based on 1% tolerance. Resistor value is only recommended based on the % in the first column. Any resistance divider value can be selected as long as the ratio meets requirements.

Table 6. CONFIG Pin Configurations for Open to Close Loop Handoff Threshold (continued)

Config Pin (% V_{CC}) Ratio of (R3 / (R2 + R3))	Open to Close Handoff Threshold (Hz)	Config Pin Voltage for V_{CC} = 5 V	Suggested Resistance Value (1)	
			R3 (kΩ)	R2 (kΩ)
59.3	112.5	2.97	10.8989	7.4416
65.6	125	3.28	10.8989	5.4761
71.9	137.5	3.60	10.8989	4.2546
78.1	150	3.91	10.8989	3.2017
84.4	162.5	4.22	10.8989	2.1522
90.6	175	4.53	10.8989	0.98806
96.9	187.5	4.85	10.8989	0.32393

The selection of handoff threshold can be determined by experimental testing. The goal is to choose a handoff threshold that is as low as possible and allows the motor to smoothly and reliably transition between the open loop acceleration and the closed loop acceleration. Normally higher speed motors (maximum speed) require a higher handoff threshold because higher speed motors have lower Kt, and as a result, lower BEMF. Table 7 shows the configurable settings for the handoff threshold. Maximum speeds in electrical Hz are shown as a guide to assist in identifying the appropriate handoff speed for a particular application.

Table 7. Recommend Handoff Threshold Based on Maximum Speed of Operation

Maximum Speed (Hz)	Handoff Frequency (Hz)		Maximum Speed (Hz)	Handoff Frequency (Hz)
< 100	12.5		450 to ≈500	112.5
100 to ≈150	25		500 to ≈560	125
150 to ≈200	37.5		560 to ≈620	137.5
200 to ≈250	50		620 to ≈700	150
250 to ≈300	62.5		700 to ≈800	162.5
300 to ≈350	75		800 to ≈900	175
350 to ≈400	87.5		> 900	187.5
400 to ≈450	100			

Figure 4 shows the phase current for the case where the open to close loop handoff threshold is set to a higher value than required. So in such cases, TI recommends reducing the open to close loop handoff threshold. Figure 5 shows the phase current for the case where the open to close loop handoff threshold is low; it is possible that the motor will fail to start. In such cases, it is recommended to increase the open to close loop handoff threshold. Figure 6 shows the phase current for properly tuned open to close loop handoff threshold.

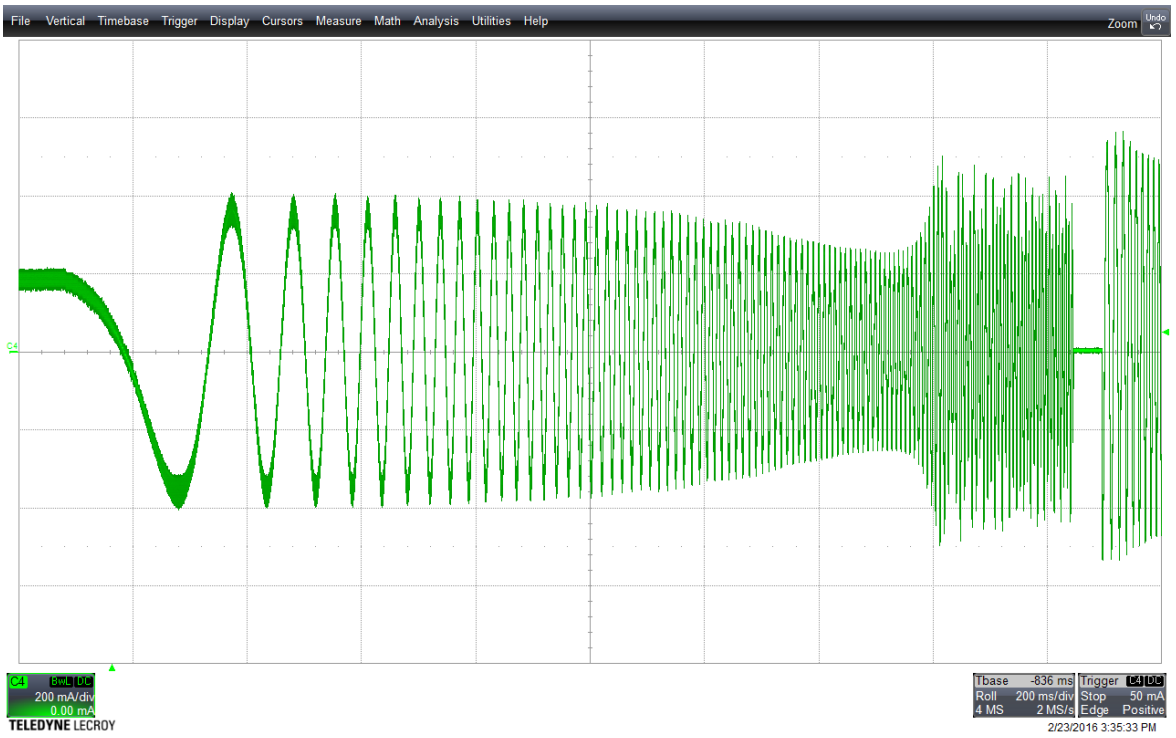


Figure 4. Phase Current for High Open to Close Loop Handoff Threshold

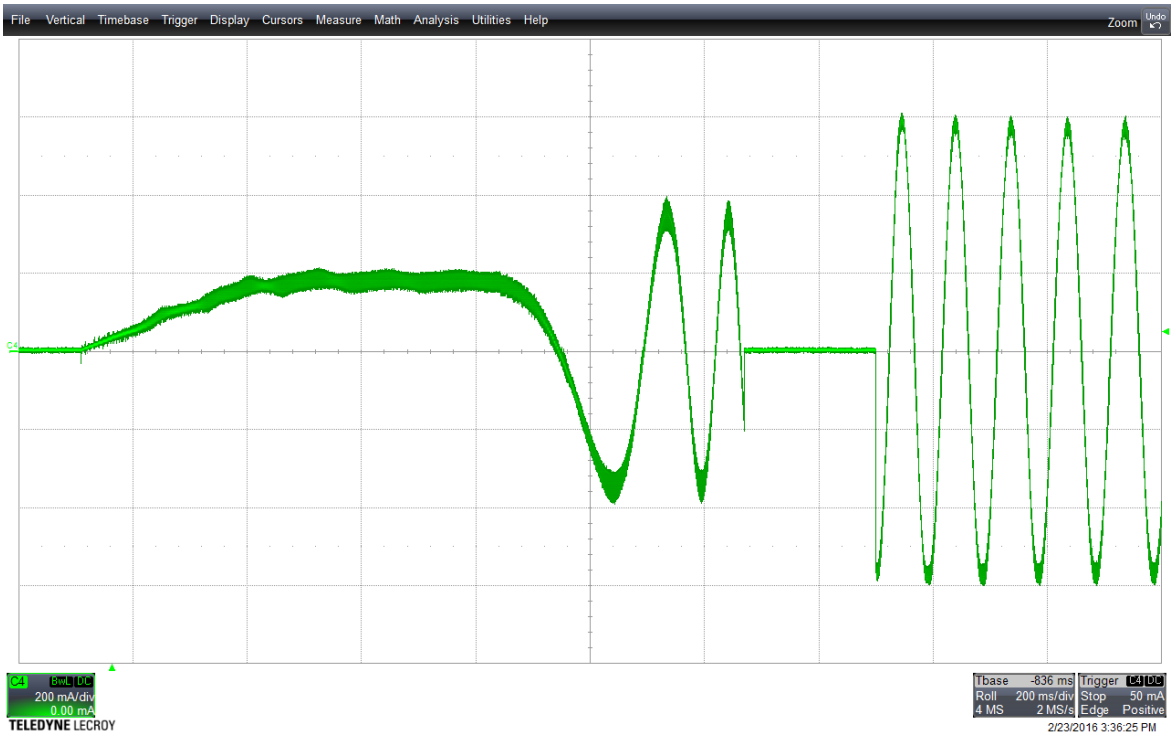


Figure 5. Phase Current for Low Open to Close Loop Handoff Threshold

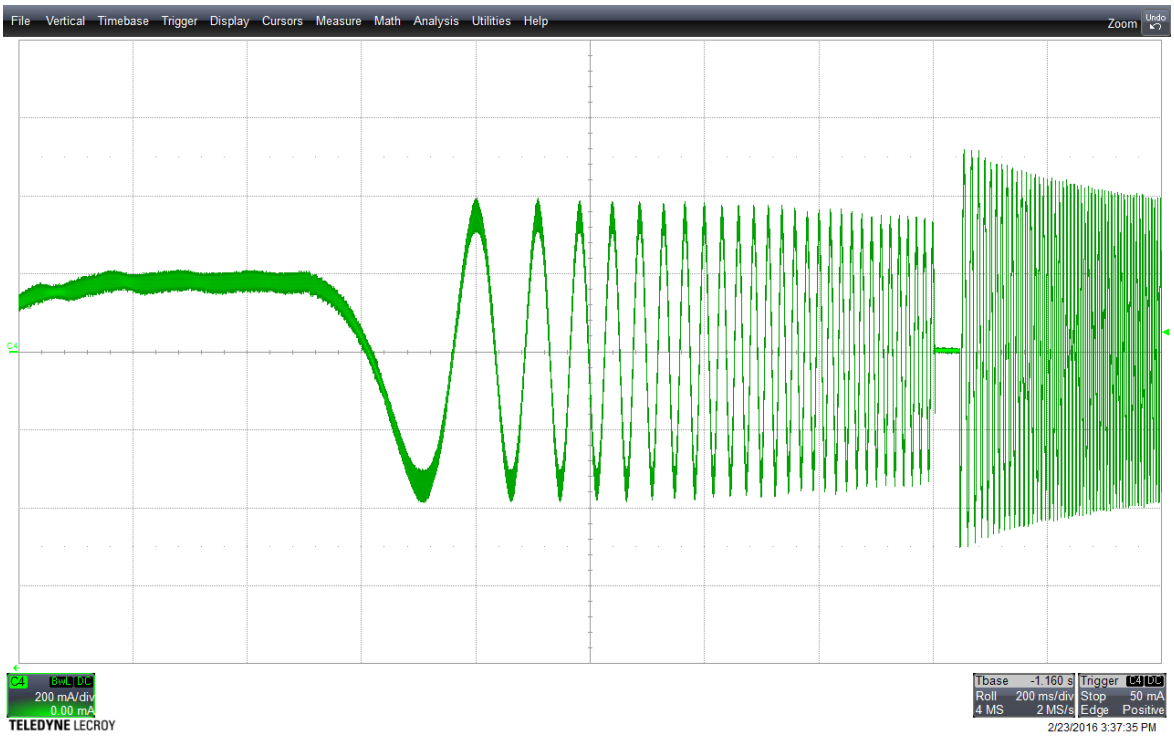


Figure 6. Phase Current for Properly Tuned Open to Close Loop Handoff Threshold

8 EVM Documentation

The EVM schematics, layout, and bill of materials (BOM) are provided in the DRV10964EVM Hardware Files.

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (February 2016) to A Revision	Page
• Changed the *CONFIG Pin Configurations for Open to Close Loop Handoff Threshold* table	7

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      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
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Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

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3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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