TPS7A64xxEVM Evaluation Module

1 Introduction

The Texas Instruments TPS7A64xxQPWP EVM evaluation module (EVM) helps designers evaluate the operation and performance of the TPS7A64xxQPWP linear regulator.

The EVM contains one linear regulator (see Table 1).

Table 1. Device and Package Configurations

CONVERTER	IC	PACKAGE
U1	TPS7A64xxQPWPRQ1(1)	PWP-14

(1) where xx is 01 for adjustable output voltage, 33 for 3.3V output and 50 for 5.0V output.

2 Setup

This section describes the jumpers and connectors on the EVM as well and how to properly connect, set up and use the TPS7A64xxQPWP EVM.

2.1 Input/Output Connector Description

VBAT is the protected power input for the regulator. The test point provides a power (Vbat) connection and a reverse battery protection diode to allow the user to power the EVM.

GND is the ground return for the regulator. The EVM provides four GND test points to allow the user to power the EVM, connect the load and attach an oscilloscope ground lead.

VOUT is power output for the regulator. The test point provides a connection to attach a load to the EVM.

The TPS7A6401QPWP EVM is setup to provide a 5V output voltage, but the feedback resistors can be changed to set the output voltage to a value between 2.5V and 7V using Equation 1

Feedback Resistor Calculation

$$V_{OUT} = 1.23 * (1 + \frac{R5}{R4}) \quad (1)$$

The TPS7A6433QPWP has a fixed outputvoltage of 3.3V without external resistors. R4 and R5 are not populated on the TPS7A6433QPWP EVM.

The TPS7A6450QPWP has a fixed outputvoltage of 5.0V without external resistors. R4 and R5 are not populated on the TPS7A6450QPWP EVM.

EN is a test point to monitor the Enable input to the device. It can also be used to provide an enable signal to the device from an outside source, if the EN jumper is left open. The EN jumper will disable the regulator when removed and enable the regulator when installed.

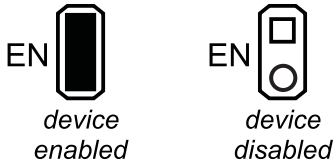

Figure 1. Enable Jumper

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nRST is the test point to monitor the reset output pin. It will show a high-level after power-up and the set DELAY, and is triggered for a low-pulse in case of an undervoltage-condition on Vout or if the watchdog is not or improperly triggered. The duration of the pulse in case of a watchdog failure equals 1/fOSC and can be used to verify the internal clock frequency. If the jumper is changed on ROSC, a power-cycle is required, since the value is only recognized during power-up. In case of an undervoltage condition, it will stay low for as long as the condition lasts, plus tPOR. See the datasheet for more details.

DELAY Jumper allows selection of the reset delay timer using an external capacitor to ground. Connecting more jumpers adds the respective delay times.

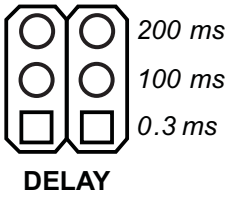

Figure 2. Delay Jumper

WD_EN This Jumper enables the watchdog. With the Jumper installed it is disabled, open is enabled.

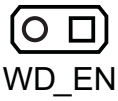

Figure 3. Watchdog-Enable Jumper

WD is the Service pin to provide a trigger signal to the Watchdog-timer by connecting it to a signal generator.

Figure 4. Watchdog-Service Pin

The Watchdog needs to get serviced with a frequency calculated per Equation 2:

$$t_{WD} = 10\text{-}6 \; x \; R_{OSC} = 5000 \; x \; 1/f_{OSC}$$

$$t_{WD_HOLD} = 3x \; t_{WD_OUT}$$

$$t_{WD_OUT} = 1/f_{OSC}$$

$$t_{CW} = t_{OW} = 1/2 \; t_{WD} \quad (2)$$

Where

t_{WD} = width of watchdog window
R_{OSC} = resistor connected at ROSC pin
t_{WD_OUT} = width of fault output
f_{OSC} = frequency of internal oscillator
t_{CW} = width of close window
t_{OW} = width of open window

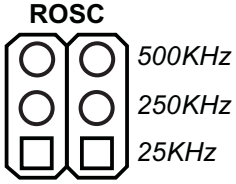

Figure 5. Watchdog-Oscillator Jumper

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The frequency set by the ROSC represents the internal clocking of the watchdog.The status of this pin is only read during power-up, hence a power-cycle is required for the change to take effect. Allow sufficient time for the input/output capacitors to discharge (several seconds if no load is present). The service frequency needs to be ~3500 times lower. If all jumpers are left open, the device defaults to approximately 30kHz.

The options given by the EVM (changing resistors gives more) are listed in Table 2, indicating the range of the service-frequency.

Table 2. Watchdog Setting

SETTING (kHz)	ROSC (kΩ)	SERVICE FREQUENCY MIN (Hz)	SERVICE FREQUENCY MAX (Hz)
25.0	200	6	9
250.0	20	60	90
500.0	10	120	180
Open Jumper	open	7	12

WD_FLT is the output of the watchdog. For the TPS7A6**4**xx, it represents the **WD_FLAG**-signal. If properly triggered, it stays low. If not or improperly triggered, it will transition to high and is latched. It can be reset (set to low) by either disabling and re-enabling the watchdog by installing and removing the WD_EN-jumper or if the WD is triggered during an Open Watchdog Initialization Window.

2.2 Setup

The input voltage range for the converter is (V_{OUT} + 0.3V) volts to 40 volts. The EVM can support up to 300mA of load current.

2.3 Operation

The TPS7A64xxQPWP will power-up after the V_{BAT} voltage has exceeded the Power-On Reset threshold.

In this configuration, the device will power up when power is applied.

3 Board Layout

Figure 6, Figure 7, and Figure 8 show the board layout for the TPS7A64xxQPWP EVM PCB.

The PowerPAD™ package offers an exposed thermal pad to enhance thermal performance. This must be soldered to the copper landing on the PCB for optimal performance. The PCB provides 2 oz copper planes on the top and bottom to dissipate heat.

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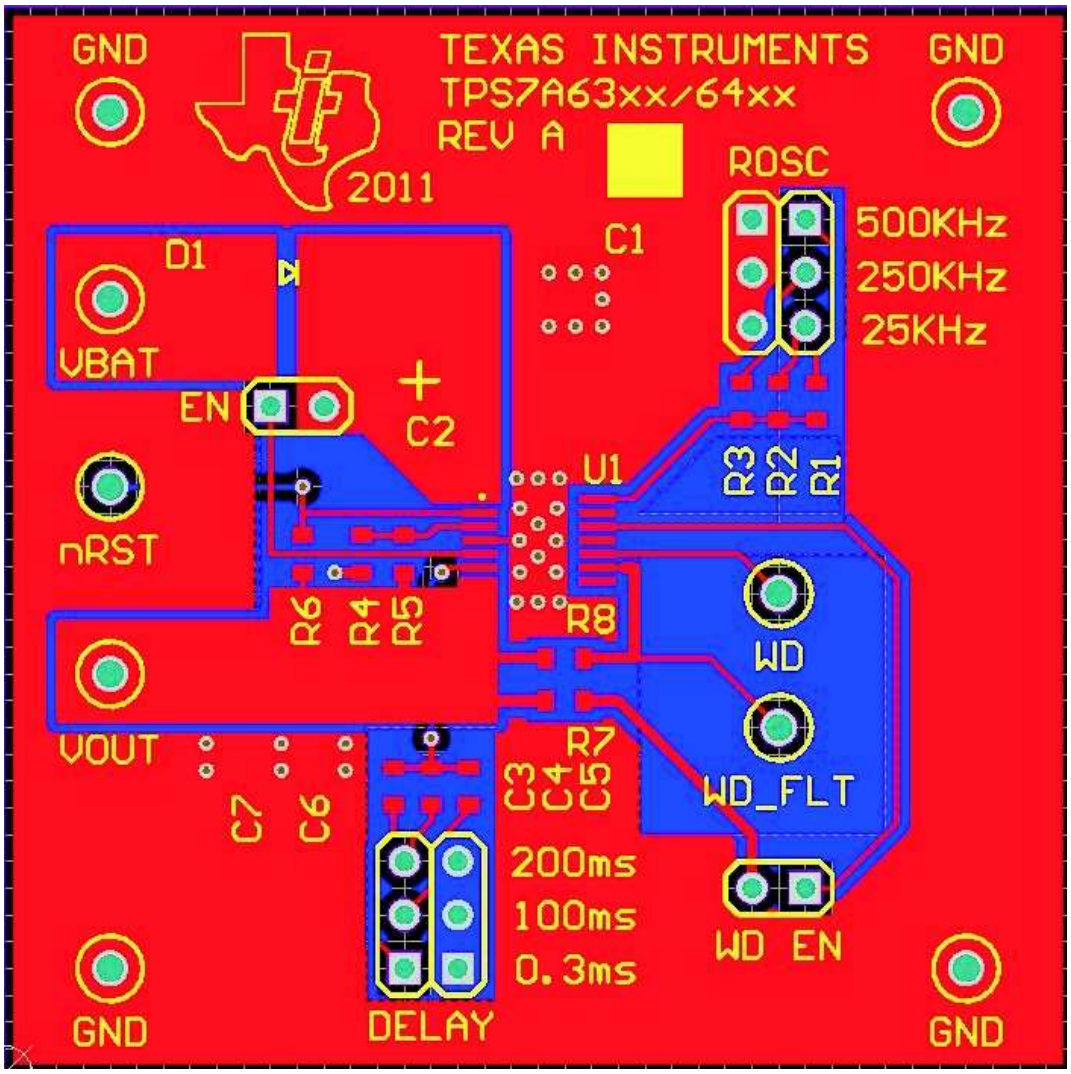

Figure 6. Top Assembly Layer

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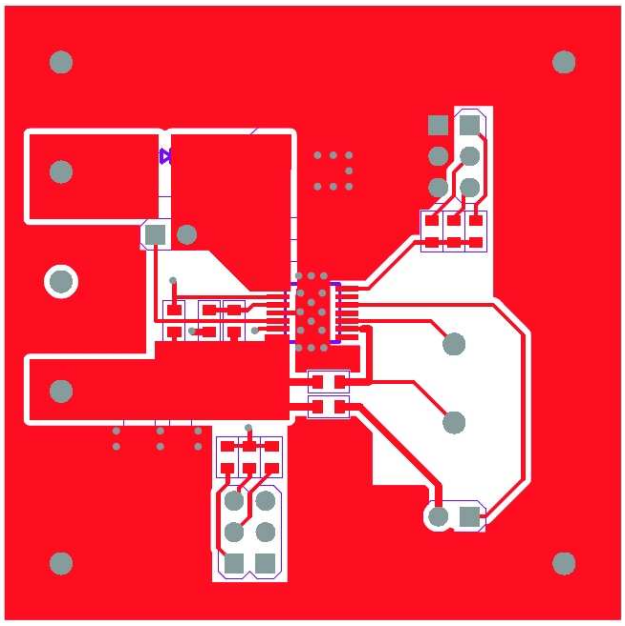

Figure 7. Top Layer Routing

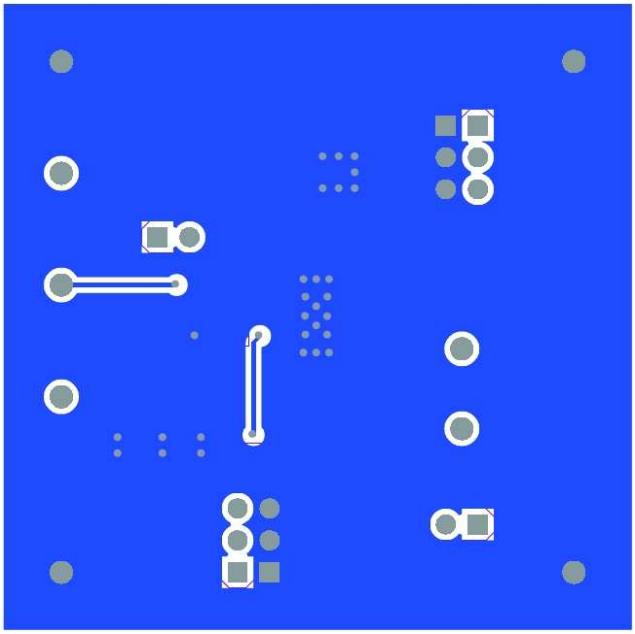

Figure 8. Bottom Layer Routing

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4 Schematic and Bill of Materials

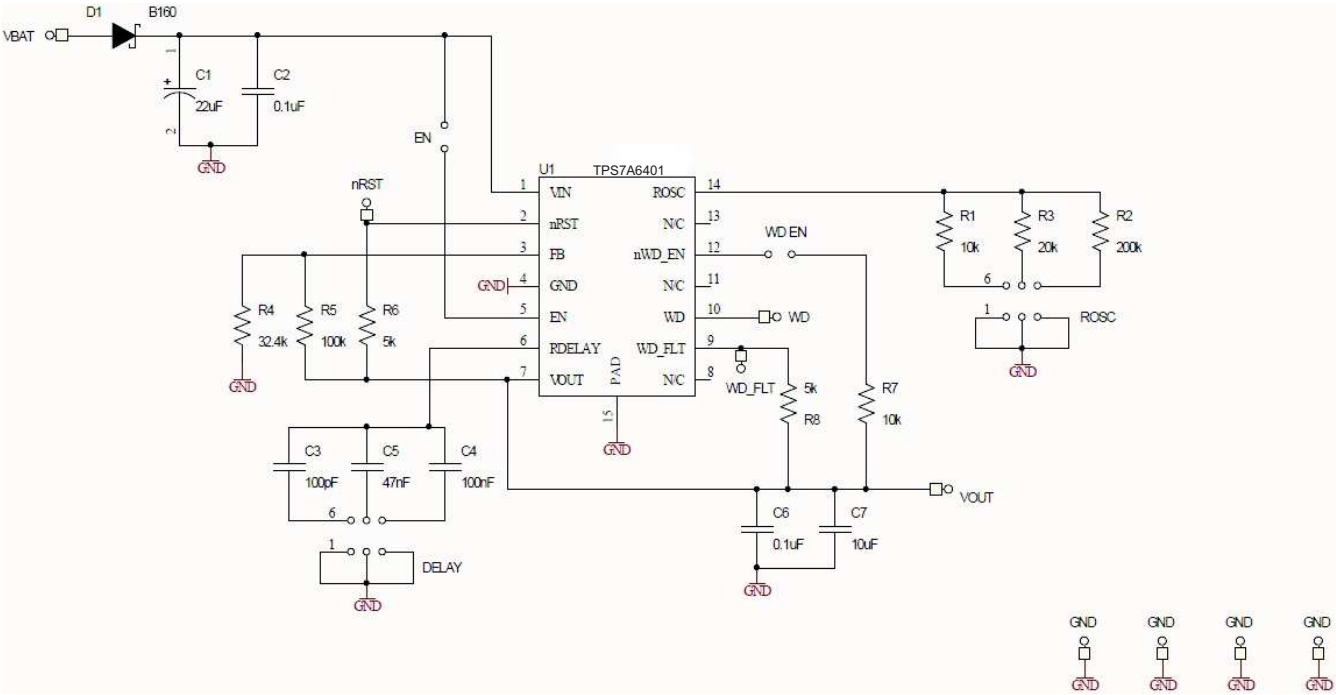

Figure 9. TPS7A64xxQPWP EVM Schematic

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Table 3. Bill of Materials

COUNT	REF DES	DESCRIPTION	SIZE	MFR	PART NUMBER
1	C1	Capacitor, electrolytic, 22uF, 50V	6.3mm x 5.8mm	Panasonic	EEV-FK1H220P
2	C2, C6	Capacitor, ceramic, 0.1uF, 50V, 10%	603	muRata	GCM188R71H104KA57
1	C7	Capacitor, ceramic, 10uF, 16V, 10%	1206	muRata	GRM31CR71C106KAC7
1	C3	Capacitor, ceramic, 100pF, 50V, 5%	603	muRata	GCM1885C1H101JA16
1	C5	Capacitor, ceramic, 33nF, 50V, 10%	603	muRata	GRM188R71H333KA61
1	C4	Capacitor, ceramic, 68nF, 50V, 10%	603	muRata	GRM188R71H683KA93
1	D1	Diode, Schottky, 1A, 60V	SMA	Diodes	B160-13-F
8	GND (x4), nRST, VBAT, VOUT, WD_FLT/	Test point, 52-mil	0.052	Kobiconn	151-103-RC
2	DELAY, ROSC	Header, 6-pin, 100-mil spacing, (36-pin strip)	0.100 x 3	Sullins	PEC03DAAN
3	EN, WD_EN, WD_FLT	Connector jumper, shorting, 100-mil spacing	0.1	Sullins	SPC02SYAN
2	R1, R7	Resistor, chip, 10-kΩ, 1/10W, 1%	603	Panasonic	ERJ-3GEYJ103V
1	R2	Resistor, chip, 200-kΩ,1/10W, 1%	603	Panasonic	ERJ-3GEYJ204V
1	R3	Resistor, chip, 20-kΩ,1/10W, 1%	603	Panasonic	ERJ-3EKF2002V
1	R4	Resistor, chip, 32.4-kΩ, 1/10W, 1% (Not Populated on TPS7A6433 EVM and TPS7A6450 EVM)	603	Panasonic	ERJ-3EKF3242V
1	R5	Resistor, chip, 100-kΩ, 1/10W, 1% (Not Populated on TPS7A6433 EVM and TPS7A6450 EVM)	603	Panasonic	ERJ-3GEYJ104V
2	R6, R8	Resistor, chip, 4.99-kΩ, 1/10W, 1%	603	Panasonic	ERJ-3EKF4991V
1	R9	do not populate			
1	U1	IC, TPS7A64xxQPWPQ1		TI	TPS7A64xxQPWPQ1
	-	PCB, 2-inch x 2-inch x 0.062		Any	TPS7A64xx_64xx, REV A

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It is important to operate this EVM within the input voltage range of 4 V to 40 V and the output voltage range of 5 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 85°C. The EVM is designed to operate properly with certain components above 60°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

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.

FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- 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.
- Consult the dealer or an experienced radio/TV technician for help.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs including detachable antennas

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

Concernant les EVMs avec appareils radio

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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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This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

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