TPS27S100x Evaluation Module

The TPS27S100x evaluation module is designed to evaluate the TPS27S100x integrated circuit. This user's guide provides the connectors and test point description, schematic, bill of materials (BOM), and board layout of the EVM.

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1 Introduction

Texas Instruments TPS27S100x evaluation module contains a TPS27S100x integrated circuit (IC), supporting single-channel high-side driver applications. The purpose of this EVM is to facilitate evaluation of the TPS27S100x for resistive, capacitive, and inductive loads.

1.1 Descriptions

The Texas Instruments TPS27S100x EVM helps designers evaluate the operation and performance of the TPS27S100x.

The TPS27S100x is a fully-protected high-side switch, with integrated NMOS power FET, and charge pump. Full diagnostics and high-accuracy current monitor features enable intelligent control of the load. Programmable current limit function greatly improves system reliability.

The device diagnostic reporting has two versions to support both open drain fault output (TPS27S100A) and analog current monitoring report (TPS27S100B). The diagnostics can be disabled for multiplexing the current monitor pin between different devices.

1.2 Applications

This EVM is used in the following applications:

- Programmable logic controller
- Telecom and networks
- Building automation
- General resistive, inductive, and capacitive loads

1.3 Features

This EVM has the following features:

- 80-mΩ, single-channel, high-side power switch with full diagnostics
  - TPS27S100A: Open-drain status output
  - TPS27S100B: Current monitor analog output
- Operating voltage 3.5 to 40 V
- Operating junction temperature: –40ºC to 150ºC
- Low standby current: <1 µA
- Microcontroller input control: 3.3-V and 5-V logic compatible
- High-accuracy current monitor, ±30 mA at 1 A, ±4 mA at 5 mA
- Programmable current limit with external resistor, ±20% at 0.5 A
- Protection
  - Overload and short-circuit-to-GND protection
  - Inductive load negative voltage clamp
  - Undervoltage lockout (UVLO) protection
  - Thermal shutdown and thermal swing with self-recovery
  - Loss of GND Protection
- Diagnostics
  - On- and Off-state output open-load and short to supply detection
  - Overload and short to ground detection
  - Thermal shutdown and swing detection

2 TPS27S100x Schematic

Figure 1 illustrates the TPS27S100x schematic.

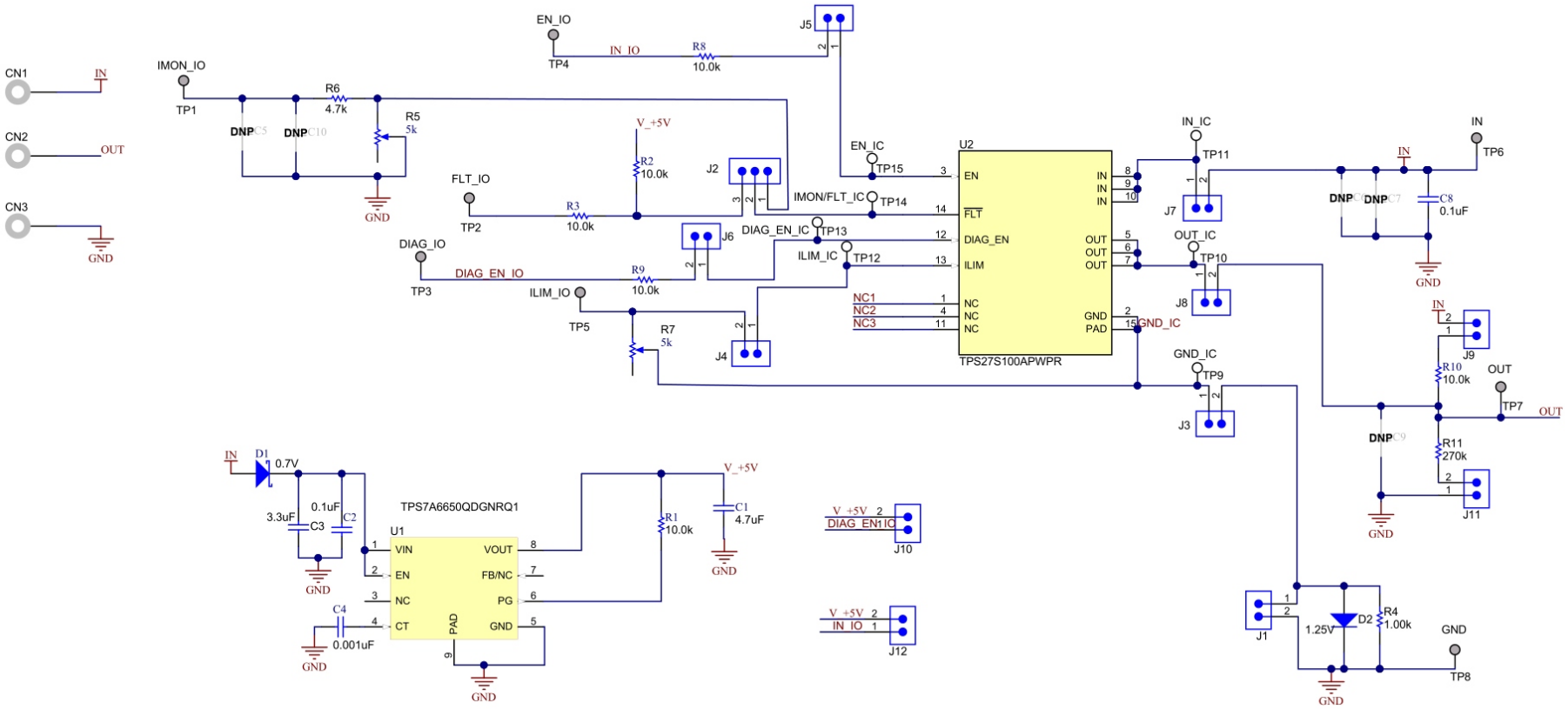

Figure 1. TPS27S100x Schematic

3 Connections Descriptions

Table 1 lists the EVM connector and test point descriptions.

Table 1. Connector and Test Point Descriptions

Connectors and Test Points	Descriptions
CN1 - IN	Board positive input supply voltage connector
CN2 - OUT	Board output pin connector
CN3 - GND	Board GND connector
GND	Board GND connector
EN_IO	Board enable connector, 3.3- or 5-V control signal connection pin
OUT	Board output pin connector
FLT_IO	Board status output connector, only effective for TPS27S100A
IMON_IO	Board current monitor output connector, only effective for TPS27S100B
ILIM_IO	Board current-limit output connector
DIAG_IO	Board DIAG_EN input connector, 3.3- or 5-V control signal connection pin
IN	Board positive input supply voltage connector
GND_IC	IC GND test point
EN_IC	IC enable test point
OUT_IC	IC output pin test point
IMON/FLT_IC	IC status output test point, effective for both TPS27S100A and TPS27S100B
ILIM_IC	IC current-limit output test point
DIAG_EN_IC	IC DIAG_EN test point
IN_IC	IC positive input supply voltage test point

Table 2 contains the EVM jumper descriptions.

Table 2. Jumper Descriptions

Jumpers	Description
J1	This jumper is used to short IC GND and board GND. When floating, there is a diode in parallel with a resistor between IC GND and board GND, which is designed for the reverse polarity protection.
J2	This jumper is used to select FLT or IMON functions. For the TPS27S100A, short pin 2 and pin 3, and for the TPS27S100B, short pin 2 and pin 1.
J3	This jumper is used to isolate GND_IC from board GND
J4	This jumper is used to isolate ILIM_IC from ILIM_IO
J5	This jumper is used to isolate EN_IC from EN_IO
J6	This jumper is used to isolate DIAG_EN_IC from DIAG_EN_IO
J7	This jumper is used to isolate IN_IC from board IN
J8	This jumper is used to isolate OUT_IC from board OUT
J9	This jumper is used to set a pullup for OUT, if off-state open load or short to supply are required
J10	When floating, DIAG_EN _IO is controlled by the MCU. When connected, DIAG_EN_IO is pulled up to 5 V, for easy test usage.
J11	This jumper is used to set a pulldown for OUT, if detection of open load and short to supply are required
J12	When floating, EN_IO is controlled by MCU. When connected, EN_IO is pulled up to 5 V, for easy test usage.

4 TPS27S100x EVM Assembly Drawings and Layout

Figure 2 through Figure 4 show the design of the TPS27S100x PCB. The EVM was designed using FR4 material with four layers (2s2p). The board size is 80 mm × 65 mm. All components are located in an active area on the top side and active traces are provided in the top and bottom layers allowing easy viewing, probing, and evaluation. Moving components to both sides of the PCB can offer additional size reduction for space-constrained systems.

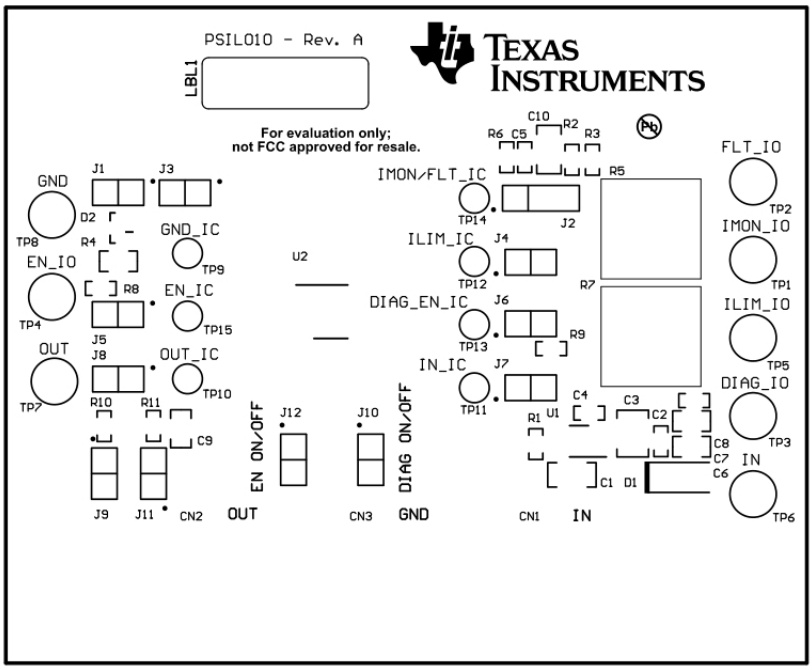

Figure 2. TPS27S100x EVM Component Placement (Top View)

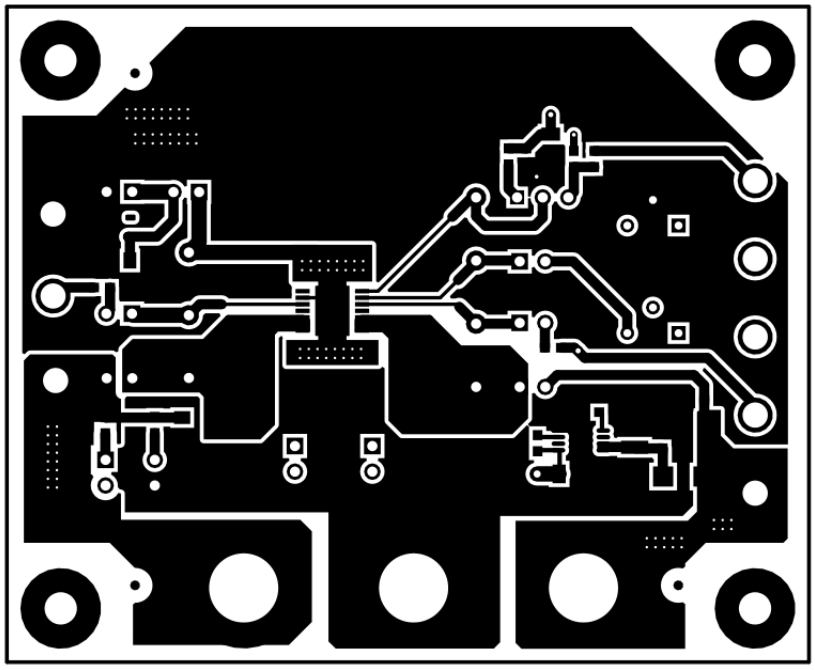

Figure 3. TPS27S100xEVM Top Layer (Top View)

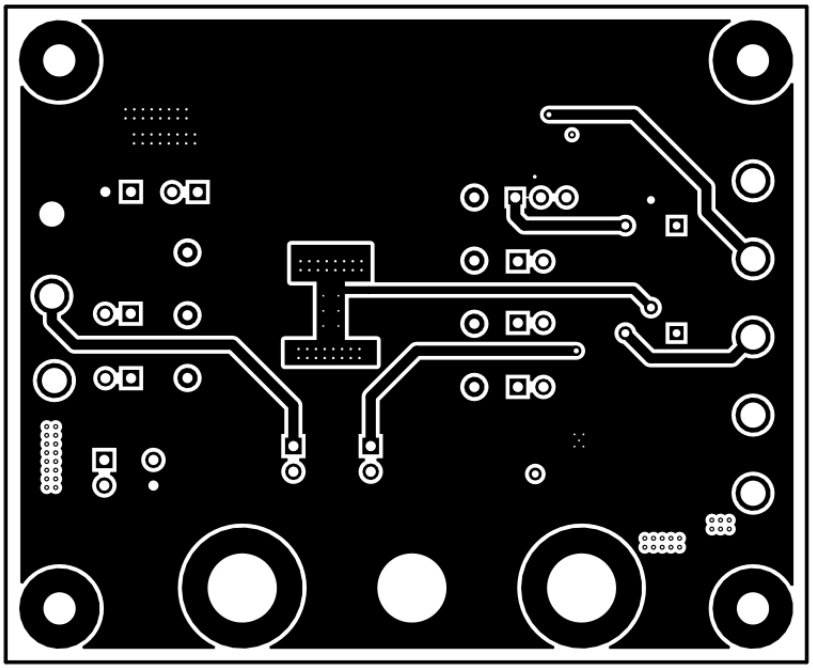

Figure 4. TPS27S100xEVM Bottom Layer (Bottom View)

5 Variable Resistor for IMON and ILIM

5.1 Current Monitor Resistor

For TPS27S100B, high-accuracy current sensing allows better real-time monitoring of effects and more accurate diagnostics without further calibration.

The current monitor resistor provides real-time output current monitoring. A current mirror is used to source $1/K_{(IMON)}$ of the load current, and is reflected as $V_{IMON} = I_{IMON} \times R_{IMON}$. When choosing the resistor, ensure the IMON voltage is in the linear region (0 to 4 V) when in normal operation.

Also, when a fault condition happens, it works as a diagnostics report pin. When an open load or short to supply event happens in on-state, V_{IMON} is almost equal to 0. When a current limit, thermal shutdown or thermal swing, open load or short to supply event in off-state happens, the voltage is clamped at $V_{IMON,H}$.

R5 is a variable resistor, from 0 Ω to 5 kΩ. The IMON resistor can be changed through R5.

5.2 Current-Limit Resistor

An external resistor is used to convert a proportional load current into a voltage, which is compared with an internal reference voltage. When the voltage on the ILIM pin exceeds the reference voltage, the current is clamped.

The inherent current limit ($I_{ILIM(int)}$) is still present when using an external current limit. The smaller value of the internal or external set value decides the actual nominal current limit. If the user decides not to use the external programmable current, tie the ILIM pin to ground.

Equation 1 and Equation 2 show an example of setting the current limit at 5 A.

$$R_{ILIM} = \frac{V_{ILIM(th)} \times K_{(ILIM)}}{I_{OUT}} \quad (1)$$

$$R_{ILIM} = \frac{V_{ILIM(th)} \times K_{(ILIM)}}{I_{OUT}} = \frac{1.233 \times 2000}{5} = 493.2\ \Omega \quad (2)$$

R7 is a variable resistor, from 0 Ω to 5 kΩ. The ILIM resistor can be changed through R7. When 0 Ω, there is no external current-limit function and the internal current limit is active. When 5 kΩ, the current-limit value is around 0.5 A.

6 Bill of Materials

Table 3 lists the EVM BOM.

Table 3. TPS27S100x EVM Bill of Materials

Designator	Quantity	Comment	Description	Footprint
C1	1	12063D475KAT2A	CAP, CERM, 4.7uF, 25V, ±10%, X5R, 1206	1206
C2, C8	2	GRM188R71H104KA93D	CAP, CERM, 0.1uF, 50V, ±10%, X7R, 0603	0603
C3	1	C3225X7R1H335M	CAP, CERM, 3.3uF, 50V, ±20%, X7R, 1210	1210
C4	1	06035A102KAT2A	CAP, CERM, 1000pF, 50V, ±10%, C0G/NP0, 0603	0603
TP9, TP10, TP11, TP12, TP13, TP14, TP15	7	5002	Test Point, TH, Miniature, White	Keystone5002
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	8	1502-2	Terminal, Turret, TH, Double	Keystone1502-2
CN1, CN2, CN3	3	108-0740-001	Standard Banana Jack, Uninsulated, 15A	Johnson_108-0740-001
D1	1	B150-13-F	Diode, Schottky, 50V, 1A, SMA	SMA
D2	1	BAS21-7-F	Diode, Switching, 200V, 0.2A, SOT-23	SOT-23
H1, H2, H3, H4	4	NY PMS 440 0025 PH	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH
H5, H6, H7, H8	4	1902C	Standoff, Hex, 0.5"L #4-40 Nylon	Keystone_1902C
J1, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12	11	TSW-102-07-G-S	Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S
J2	1	TSW-103-07-G-S	Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator	TSW-103-07-G-S
LBL1	1	Size: 0.65" x 0.20 "	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	Label_650x200
R1, R2, R3, R8, R9, R10	6	CRCW060310K0FKEA	RES, 10.0k ohm, 1%, 0.1W, 0603	0603
R4	1	CRCW08051K00FKEA	RES, 1.00k ohm, 1%, 0.125W, 0805	0805_HV
R5, R7	2	3386P-1-502LF	TRIMMER, 5k ohm, 0.5W, TH	BOURNS_3386P
R6	1	CRCW06034K70JNEA	RES, 4.7k ohm, 5%, 0.1W, 0603	0603
R11	1	RC0603FR-07270KL	RES, 270k ohm, 1%, 0.1W, 0603	0603
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9	9	969102-0000-DA	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G
U1	1	TPS7A6650QDGNRQ1	High-Voltage Ultralow-Iq Low-Dropout Regulator, DGN0008D	DGN0008D_N
U2	1	TPS27S100APWPR	TPS27S100A Single Channel Smart High Side Driver, PWP0014C	PWP0014C_N
U2	1	TPS27S100BPWPR	TPS27S100BPWPR Single Channel Smart High Side Driver, PWP0014C	PWP0014C_N

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      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

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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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      NOTE: 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

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

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3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

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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.

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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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1. Use EVMs 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 EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
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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