#### ACT88321EVK1-101 User's Guide

#### Description

This document describes the characteristic and operation of the Qorvo ACT88321EVK1-101 evaluation kit (EVK). It provides setup and operation instructions, schematic, layout, BOM, and test data. This EVK demonstrates the ACT88321VU101 Qorvo PMU power management IC. Other ACT88321VUxxx options can be evaluated on this EVK by replacing the IC and any other necessary components.

#### Features

The EVK can be used as a standalone board if desired. However, to access the internal registers and to take full advantage of the IC's capability, the user must connect the EVK kit to a PC with Qorvo's USB-TO-I2C interface dongle and use the GUI software. The EVK provides full access to each converter's input and output voltage, as well as all the digital control signals. This gives the user the flexibility to configure the EVK to match their real-world system.

Note that the ACT88321EVK1-101 is specifically configured for the ACT88321VU101. This CMI does not use Push-Button.



Figure 1 – EVK Picture

#### Setup

#### **Required Equipment**

ACT88321 EVK

USB-TO-I2C Dongle

Power supply – 3.3V @ 4A for full power operation

Oscilloscope - >100MHz, >2 channels

Loads - Electronic or resistive. 3A minimum current capability.

Digital Multi-meters (DMM)

Windows compatible computer with spare USB port.

### **EVK Setup**

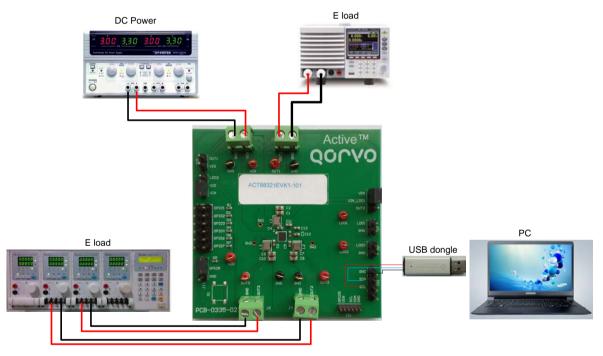


Figure 2 – EVK Setup

#### Hardware Setup

- 1. Decide which voltage will power VIO\_IN. Qorvo recommends powering VIO\_IN from the VIN input. Connect a shorting jumper between J9-2 and J9-3 header to power VIO\_IN from the VIN input voltage.
- 2. Connect a jumper between J3-1 and J3-2 header to power VIN\_LDO1 from VIN input voltage.
- 3. Connect a jumper between J13-1 and J13-2 to power GPIO5.
- 4. Connect DC source between J1-1 and J1-2 with 3.3V.
- 5. Connect an appropriate load to each power supply output.
- 6. Note that the typical setup is to apply the same 3.3V input voltage to all inputs. Using different input voltage sources requires careful consideration of startup sequencing.



Figure 3 – Shorting Jumper Settings

### **GUI Setup (optional)**

- 1. Refer to the end of this document for detailed instructions to install the ACT88321 GUI.
- 2. Connect the USB-TO-I2C dongle to the computer via a USB cable.
- 3. Connect the USB-TO-I2C dongle to the EVK J12 connector. Refer to Figure 4 to ensure the correct polarity of the connection. As a guide, use the "Active-Semi" logo on the top of the dongle so the black wire is connected toward the lower left corner of the Dongle.

Dongle Cable Connector (Black Wire Connected to GND of the J12 I2C Jumper on the ACT88321 EVK Board)





Figure 4 – USB-TO-I2C Dongle Connection

#### **Recommended Operating Conditions**

The ACT88321EVK1-101 is designed for a 3.3V input voltage. The maximum operating voltage is determined by the IC's maximum input voltage rating. The minimum operating voltages are determined by the buck converters' minimum input voltage and by the LDOs' dropout voltages. Maximum currents are determined by the IC's CMI settings, which can be changed via I2C after startup.

#### **Table 1. Recommended Operating Conditions**

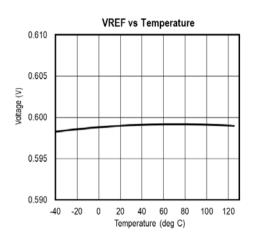
PARAMETER	VALUE	UNIT
All I/O and Power pins except PGND1, PGND2, PGND3, AGND	-0.3 to 6	V
Grounds: Any PGND referenced to AGND	-0.3 to +0.3	V
SW_Bx to PGNDx	-1 to VIN_Bx + 1	V
FB_Bx to PGNDx	-0.3 to AVIN + 0.3	V
LDO2 to AGND	-0.3 to AVINx + 0.3	V
LDO1 to AGND	-0.3 to VIN_LDO + 0.3	V
Junction to Ambient Thermal Resistance, CSP	37	°C/W
Operating Junction Temperature	-40 to 150	°C
Storage Temperature	-55 to 150	°C

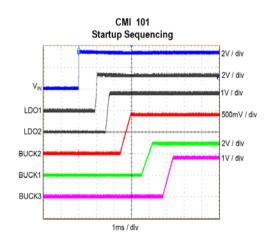
### **EVK Operation**

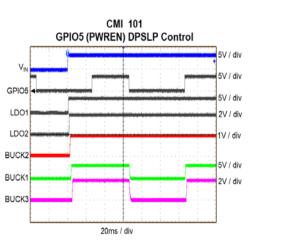
#### Turn-on

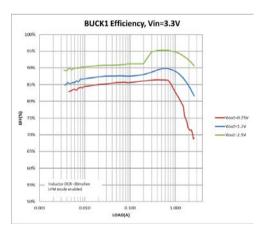
Apply the 3.3V input voltage. All outputs automatically turn on with the programmed startup sequence.

#### **Test Results**

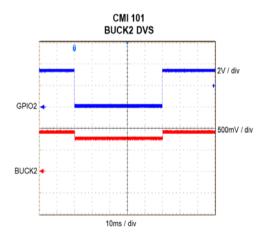


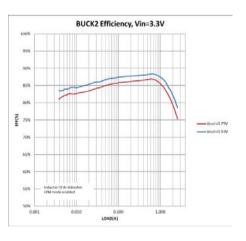




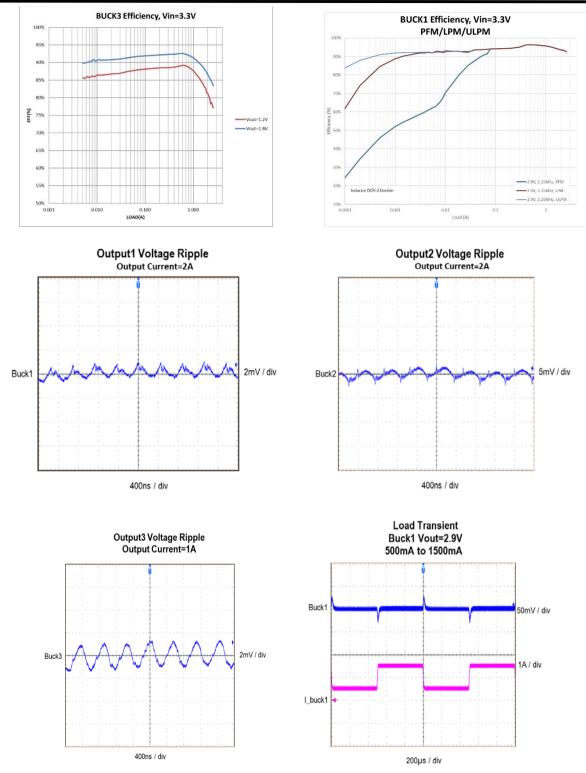




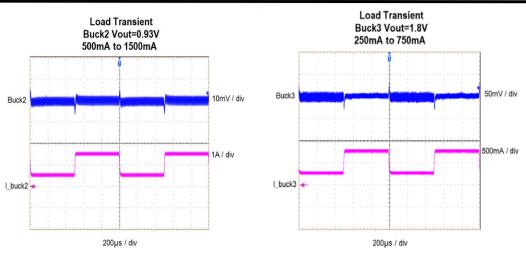




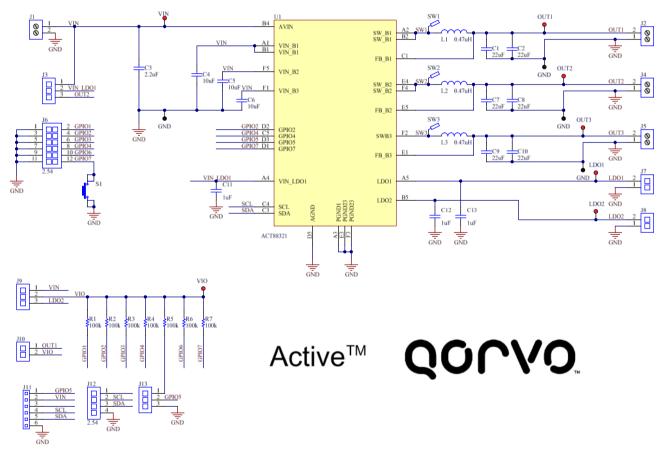
### **UG142** Rev. 1.0, 24-Nov-2020

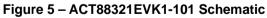


**UG142** Rev. 1.0, 24-Nov-2020



#### Schematic





### **Bill of Materials**

Table 2 - BOM

Item	Designator	Quantity	Description	Package	Manufac- turer	PartNumber
1	C1, C2, C7, C8, C9, C10	6	Cap, Ceramic, 22uF, 16V, 20%, X5R	0805	std	std
2	C3	1	Cap, Ceramic,2.2uF, 16V, 20%, X5R	0603	std	std
3	C4, C5, C6	3	Cap, Ceramic, 10uF, 16V, 20%, X5R	0603	std	std
4	C11, C12, C13	3	Cap, Ceramic, 1uF, 16V, 20%, X5R	0603	std	std
5	J1, J2, J4, J5	4	CON, Screw Terminal, 3.50, 2P, KF350		Wurth Elektronik	691214110002
6	J3, J9	2	Header, Unshrouded, 2.54, Male, 3P	CON3	Wurth Elektronik	61300211121
7	J6	1	Header, Unshrouded, 2.54, Male, 7x2P	CON7x2	Wurth Elektronik	61301421121
8	J7, J8, J10	3	Header, Unshrouded, 2.54, Male, 2P	CON2	Wurth Elektronik	61300211121
9	J11	1	Header, Unshrouded, 1.27, Male, 6P	CON6	Digekey	GRPB061VWVN- RC
10	J12	1	Header, Unshrouded, 2.54, Male, 4P	CON4	Wurth Elektronik	61300211121
11	L1, L2, L3	3	Inductor, 0.47uH	2512	Wurth Elektronik	744383240047
12	R1, R2, R3, R4, R5, R6, R7	7	Res, 100kΩ, 5%	0603	std	std
13	S1	0	Switch, TSW, TE-1437565-0		N/A	std
14	TP1, TP2, TP3, TP5, TP8, TP10, TP11	7	TEST POINT PC MINI .040"D RED		KeyStone	5000
15	TP4, TP6, TP7, TP9	4	TEST POINT PC MINI .040"D BLK		KeyStone	5001
16	U1	1	IC, ACT88321	CSP	Qorvo	ACT88321VU101

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### Layout

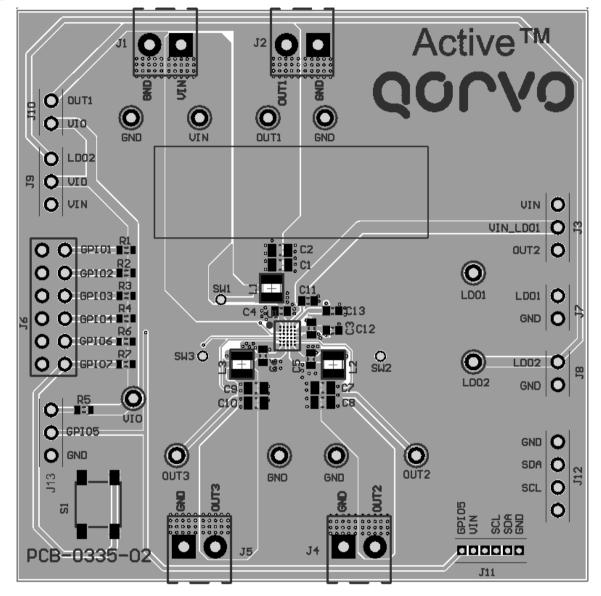


Figure 6 – Layout Top Assembly

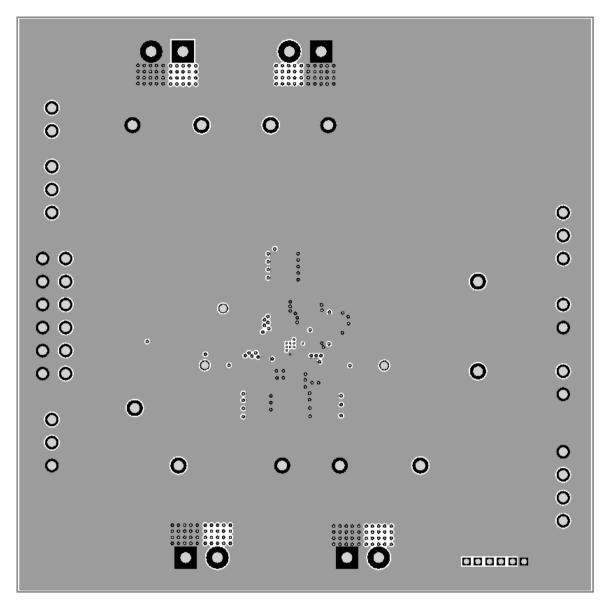


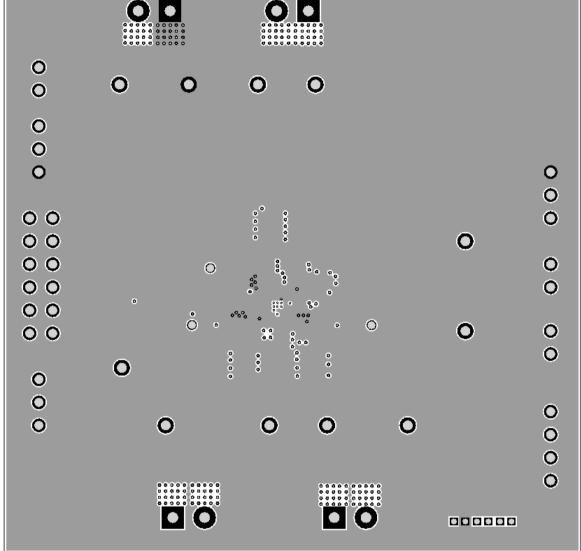
Figure 7 – Layout Layer 2

0



Figure 8 – Layout Layer 3





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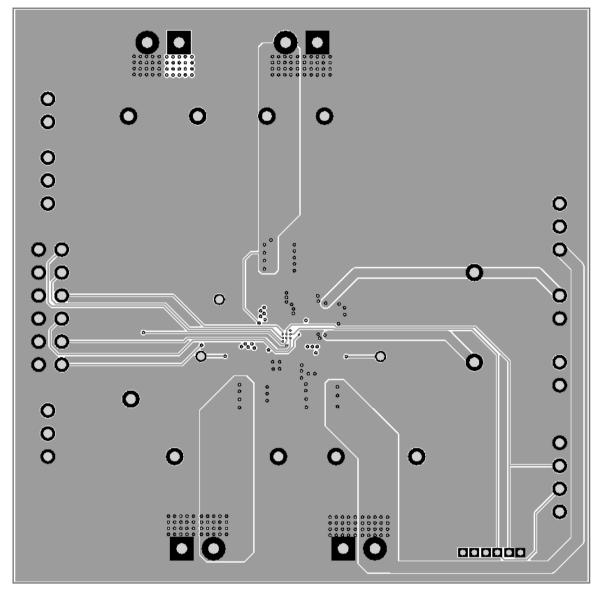


Figure 9 – Layout Bottom Layer

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#### **GUI Installation**

- 1. Download the GUI files from Qorvo's website and save them on your computer.
- 2. Plug the USB-TO-I2C dongle into a free USB port.
- 3. Double click on the ACT88321 GUI.exe to start the ACT88321 GUI.

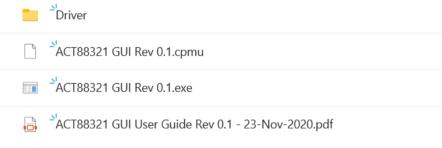


Figure 10 – Dongle Driver

#### **GUI Overview**

The GUI has 2 basic function buttons allocated in top-left of the Tool Bar which are Read and Write I2C. The GUI contains 2 setting modes: Basic Mode and Advanced Mode. In Basic Mode screen it displays basic user programmable configuration options are programmed using the drop-down boxes or check boxes. Advanced Mode contains the button text for changing setting for every single bit.

#### **Basic Mode**

The following figure shows the GUI in basic mode. This mode allows the user to easily change one or more IC settings.

ACT88321 GUI REV	? 础			ACT	88321							-		•
Basic Mode	SYSTEM CONTROL			REGULATORS										
Advanced Mode	12C Address	0x2	h		BU	BUCK1		BUCK2			LDO1	LDO2		
	Tile Trigger Interrupt	MST	B	ON BR										
				SLEEP_EN Bt										
	VIN_POK_OV (V)	3.5	~	DPSLP_EN Bit										
	VSYSMON (V)	2.7	~	VSET0 (V)	0.60	0 ~ 0	0.50	~	0.50	~	0.60	×	0.60	~
	VSYSWARN (V)	2.7	~	VSET1 (V)	0.60		0.50	_	0.50	_				
	nRESET Time (ms)	0.5	~					~		~				
				Current Limit (A)	3.7	5 ~	3.75	~	2.0	~	0.35	~	0.35	~
	LDO1 Operation Mode	Regul	der.	Soft Start Time (	(us) 500	) v	50	~	50	×	160	$\sim$	160	
				DVS Rate (mV/	us)		22.5	i i						
	LDO2 Operation Mode	Regul	ator	Startup Delay (m	ns) 0	×	0	~	0	~	0	~	0	~
				Tum-off Delay (r	ns) 0	~	0	-	0	~	0	~	0	~
					_	_		_		_	0			~
				Frequency (Minz	) 2	25	1.5	9	1.5					
	GPIO <sub>S</sub> SETTING	PIO2	G	PIO4 GPI	05	GPIO	7							
	Operation Mode	NA		NA	NA	PB Ac	tive Low							
	Delay Time (ms)	0	7		0 ~	0								
						_								
OLAO	Degitch Time (ms)	0	¥ I	0 4	0 ~	0	~							

Figure 11 – GUI Basic Mode

#### **Advanced Mode**

Click the "Advanced Mode" button in the left of the GUI screen to see all available user programmable options. With Advanced Mode, additional user programmable features can be selected using the button text. In the left side of the Advanced Mode Screen, click on the Tiles Selector to display the register to view or change. Then change a register one bit at a time by clicking on the desired bit. The value of the bit is display right next to the bit-name button.

Note that the right side of the screen contains a scroll down button to scroll down to additional registers since the Tile Screen can only display up to 8 bytes at once.

/ 🗋 🐗 i	iq (	? 🖆		AC T8832	21				
Basic Mode	Bits	Address 0x00		Address 0x01		Address 0x02		Address 0x03	
Advanced Mode	7	ROM STAT	0	ROM INT MASK	0	RFU	0	RFU	0
System	6	WD TIMER ALERT	0	WD_ALERT_MASK	0	REU	0	GPIO7_STAT	0
Buck1	5	TWARN	0	TMASK	0	VSYSWARN_RT	0	REU	0
Buck2	4					and the second s		1142434	
Buck3	1 -	VSYS_STAT	0	VSYS_MASK	0	VSYSDAT	0	GPIO5_STAT	0
LDO12	3	VIN_POK_OV	0	VIN_POK_OV_MASK	0	RFU	0	GPIO4_STAT	0
	2	RFU	0	RFU	0	RFU	0	RFU	0
	1	VSYSWARN	0	VSYSWARN_MASK	0	RFU	0	GPIO2_STAT	0
	0	RFU	0	RFU	0	RFU	0	RFU	(
	Bits	Address 0x04		Address 0x05		Address 0x06		Address 0x07	
	7	RFU	0	RFU	0	INTADR[7]	0	MR	0
	6	GPIO7_Toggled	0	GPIO7_MASK	0	INTADR[6]	0	SLEEP	(
	5	RFU	0	RFU	0	INTADR[5]	0	RFU	(
	4	GPIO5_Toggled	0	GPIO5_MASK	0	INTADR[4]	0	DPSLP	
	3	GPIO4_Toggled	0	GPIO4_MASK	0	INTADR[3]	0	RFU	
	2	RFU	0	RFU	0	INTADR[2]	0	POWER_OFF	
	1	GPIO2_Toggled	0	GPIO2_MASK	0	INTADR[1]	0	WDPCEN	(
	0	RFU	0	RFU	0	INTADR[0]	0	WDSREN	(
	Bits	Address 0x09		Address 0x0A		Address 0x08		Address 0x0C	
0010	7	TRST_DLY[2]	0	RFU	0	RFU	0	IO5_DLY[1]	0
01.40	6	TRST_DLY[1]	0	RFU	0	RFU	0	105_DLY[0]	0

Figure 12 – GUI Advanced Mode

#### **Button Descriptions**

**Read:** Clicking on this button reads the ACT88321 registers and displays them in the GUI. Note that this reads all registers. Qorvo recommend spreading registers each time the ACT88321 powers-up to acquire the initial register settings. Qorvo also recommends reading registers after making changes to them. Immediately reading the registers after a write confirms the changes were properly stored.

/ 🗂 🔜 🔌	▶ ? 础		ACT88	321							•4
Basic Mode Read	SYSTEM CONTROL		REGULATORS S				-	1001			
Advanced Mode	12C Address	0x25h	0110	BUCK1		BUCK2	BUCK3	LDO1		LDO2	
	Tile Trigger Interrupt	MSTR	ON Br								
	VIN_POK_OV (V)	3.5 ~	SLEEP_EN BR								
			DPSLP_EN BE								
	VSYSMON (V)	2.7 🗸	VSET0 (V)	0.600	~	0.50 ~	0.50 ~	0.60	~	0.60	V
	VSYSWARN (V)	2.7 v			-			1			
	nRESET Time (ms)	0.5 ~	VSET1 (V)	0.600	~	0.50 ~	0.50 ~	1			
			Current Limit (A) Soft Start Time (us)	3.75		3.75 ~	2.0 ~	0.35	~	0.35	~
				500		50 v	50 v	160	~	160	
	LDO1 Operation Mode	Regulator				22.5			_		
	LDO2 Operation Mode	Regulator	DVS Rate (mV/us)			22.5					
			Startup Delay (ms)	0	¥	0 ~	0 ~	0	$\sim$	0	$\sim$
			Tum-off Delay (ms)	0	~	0 ~	0 ~	0	~	0	~
			Frequency (Mhz)	2.25	1	1.5	1.5	1			

Figure 13 – Read Button

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Write: Clicking on this button writes the GUI settings to the ACT88321's registers. All registers are written, regardless of whether or not they were changed.

1 🖄 🐗 🖥	🖉 🕐 🔂			ACT88	321									
Basic Mode	Write TEM CONTROL		_	REGULATORS S	ETTING		BUCK2		BUCK3		LD01		LDO2	
Advanced Mode	I2C Address	0x25	'n	ON Bt										
	Tile Trigger Interrupt	MST	R				_							
	VIN_POK_OV (V)	3.5 ~		SLEEP_EN BK										
				DPSLP_EN Bt										
	VSYSMON (V)	2.7	~	VSET0 (V)	0.600	~	0.50	~	0.50	~	0.60	~	0.60	3
	VSYSWARN (V)	2.7	~	VSET1 (V)	0.600	~	0.50	-	0.50	~	-			
	nRESET Time (ms)	0.5	×		and a second sec	-		_					-	_
				Current Limit (A)	3.75	~	3.75	~	2.0	~	0.35	~	0.35	~
	10010	n. 1		Soft Start Time (us) 500	500 ~ 50		50 V		Y	160	×	160		
	LDO1 Operation Mode LDO2 Operation Mode	Regul		DVS Rate (mV/us) Startup Delay (ms)			22.5							
		Regulator	ator		0	~	0	~	0	~	0	~	0	
				Turn-off Delay (ms)	0	v	0	×	0	v	0	~	0	
				Frequency (Mhz)	2.25	22	1.5		1.5					

Figure 14 – Write Button

**Dongle Connection Status:** The GUI also contains a dongle is connected status which indicates that Qorvo's USB-TO-I2C dongle is connected to the USB port of the driver installed. The figure below shows the two possible indication status graphics.





Figure 15 – Dongle Connection Status

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