HybridKit Drive Advanced Features

HybridKit Drive Manual for using Advanced Features

About this document

This application note describes advanced programmable features of the evaluation kits "*HybridKit Drive*" and "*HybridKit Drive Sense*". Before using the advanced features it is required to read and understand the safety warnings (section 1.1) and to get familiar with the basic operation of the evaluation kits – the so called DEMO-MODE. Please read the application note AN-HPDKIT-QUICKSTART before starting with the advanced features.
Author: Tomas Reiter (IFAG ATV HP EDT MD).

Scope and purpose

For more advanced evaluation tests it can be useful to adjust certain inverter system parameters. With a simple terminal program (USB – RS232 connection) different PWM dead times, two level turn-on, two level turn-off, switching frequency settings can be programmed. The programmed parameters are saved in the evaluation kit and are applied also in the simple DEMO-MODE, which does not need a communication during run-time.

For safety reasons the USB cable has to be always disconnected when the evaluation kit is operated under load and high voltages. For communication during an inverter operation an isolated CAN card can be used. Please note that the evaluation kit is designed for lab testing and no protection mechanism is implemented, which avoids or stops the operation in case critical or wrong parameters are applied for a specific test.
Please repect the datasheet and maximum ratings of the devices in order to avoid damage on the evaluation kit and the lab equipment.

Intended audience

Experienced engineers, which are already familiar with the basic operation of the evaluation kit.
(see Appnote AN-HPDKIT-QUICKSTART).

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1 Introduction

The evaluation kit *HybridKit Drive* and *HybridKit Drive* Sense are full inverter systems including B6 bridge power modules, gate driver board, micro-controller logic board, dc-link capacitor and cooling. The evaluation kits support the customers in their first steps designing applications with the HybridPACK™ Drive.

This application note describes advanced programmable features of the evaluation kits, which may be useful for a deeper investigation of the module performance and helps for understanding parameter tradeoffs for switching frequency, PWM dead times, two level turn-on, etc.

Please note that USB/RS232 communication method is not suited for noisy lab environments and thus the connection typically fails during inverter operation. This communication method is well suited for a simple parameter adjustment and printing out a status report rather than datalogging during a test. Please ensure that the USB cable is disconnected during high voltage and/or high current load tests.
For communication during an inverter operation an isolated CAN card can be used.

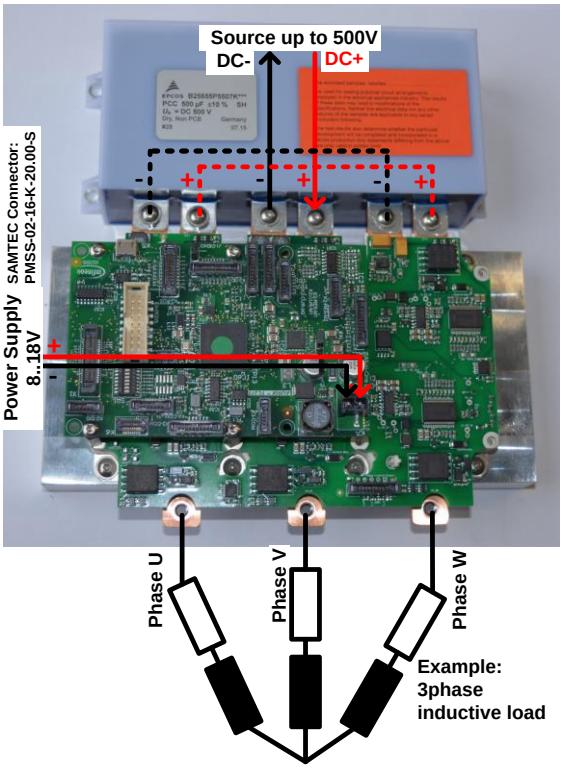

Figure 1 HybridKIT Drive typical appearance and connections.

Please read and understand the manual and the following safety warnings (see section 1.1).

1.1 Safety Warning for Evaluation Kit

The design operates with unprotected high voltages. Therefore, the Evaluation Kit may only be handled by persons with sufficient electrical engineering training and experience. The customer assumes all responsibility and liability for its correct handling and/or use of the Evaluation Kit and undertakes to indemnify and hold Infineon Technologies harmless from any third party claim in connection with or arising out of the use and/or handling of the Evaluation Kit by the customer.
The Evaluation Kit is a sample to be used by the customer solely for the purpose of evaluation and testing. It is not a commercialized product and shall not be used for series production. The Evaluation Kit is thus not intended to meet any automotive qualifications. Due to the purpose of the system, it is not subjected to the same procedures regarding Returned Material Analysis (RMA), Process Change Notification (PCN) and Product Withdraw (PWD) as regular products. See Legal Disclaimer and Warnings for further restrictions on Infineon Technologies warranty and liability.
European legislation in relation to inter alia the restriction of hazardous substances (RoHS), waste from electrical and electronic equipment (WEEE), electromagnetic compatibility, as well as duties to comply with CE, FCC or UL standards do not apply to the Evaluation Kit and the Evaluation Kit may not fulfill such requirements.

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2 Recommended Equipment and Software

The advanced features can be only used with a communication between a PC and the evaluation kit. Therefore, additional lab equipment and software is required before parameters can be adjusted:

Equipment:

- **PC** with Windows operating system and local admin rights (recommeded Win7 or later).
- **DAP miniWiggler** for flashing latest software version into the evaluation kit
  Infineon SAP order number: **SP001116850**
- **USB cable** (PC: USB A-male connector to LogicBoard: USB Micro B-male connector)
- **CAN card** for communication during inverter operation (preffered PCAN-USB opto-decoupled)

Software and Drivers:

- Infineon MEMTOOL (V4.7.2 or later).
  http://www.infineon.com
- FTDI Chip USB-RS232 serial driver.
  http://www.ftdichip.com/Drivers/VCP.htm
- Terminal Programm (e.g. Tera Term)
  http://ttssh2.osdn.jp/index.html.en
- CAN driver (depending on CAN card)

3 Flashing new Software into LogicBoard

3.1 Memtool initialization

These steps are initially required to setup the Infineon Memtool for the target AURIX Microcontroller implemented on the evaluation kit. In case the Memtool is already prepared please continue with next section describing the flash process itself.

- Open the Memtool.
- Target: Change (Figure 2a).
- Select “New” (Figure 2b).
- Create a new target configuration step by step (Figure 2c).
- Give a Target Description e.g. “HybridKit Drive TC277 C” and select Infineon TriCore Family (Figure 2d).
- Select Type “TC277T-64F200-C” (Figure 2e).
- Select Communication Device/Protocol: “ Tricore2 JTAG/OCDS Interface” (Figure 2f).
- Select entire memory area (Figure 2g).
- Save configuration file e.g. “HybridKit_Drive.cfg” (Figure 2h)

Figure 2 illustrates the required steps for inizialization of the Memtool for the right target device.

Once the target configuration file is saved it is convenient to flash hex files to the logic board. Please continue with section 3.2 for the flash process itself.

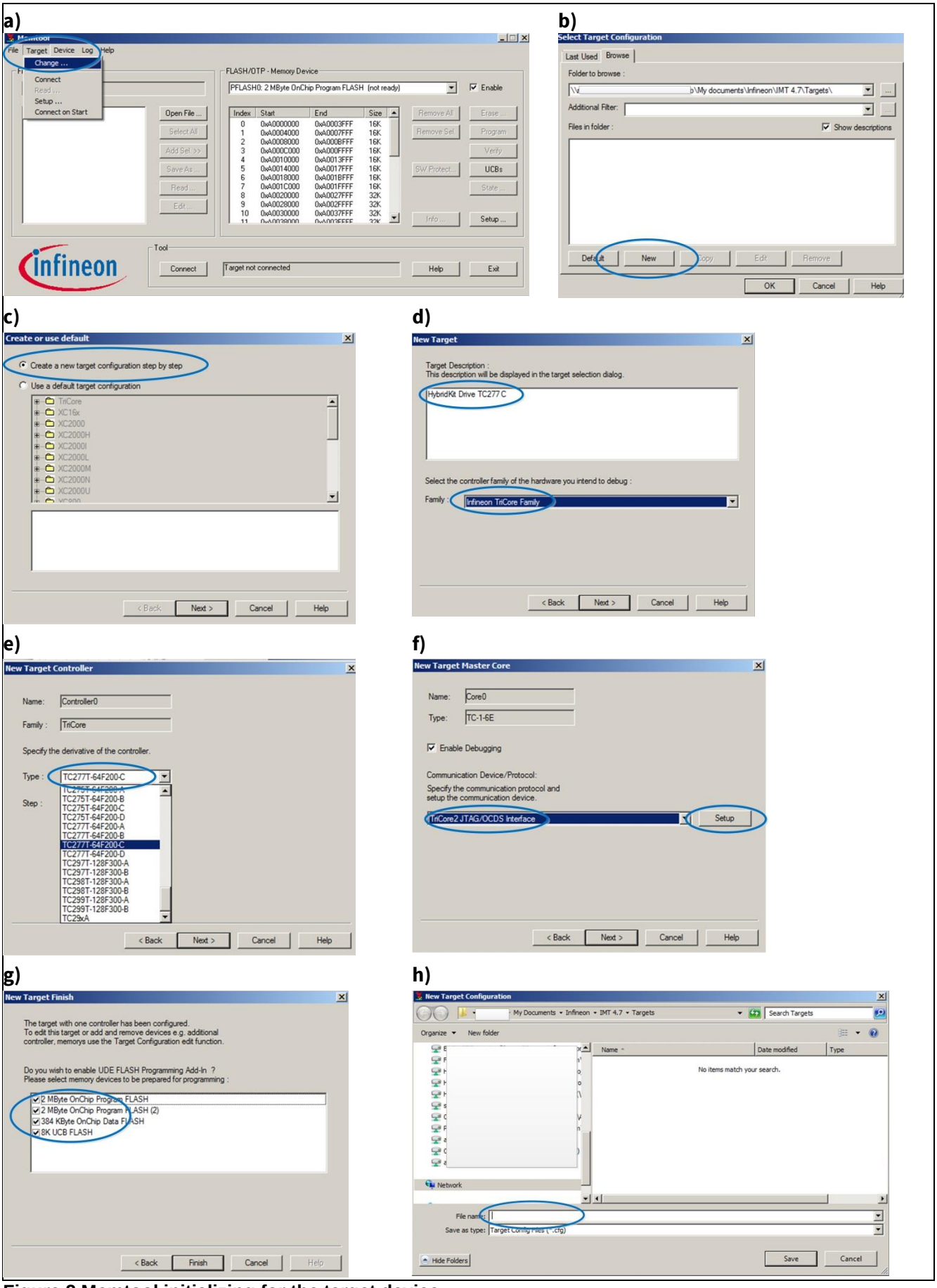


Figure 2 Memtool initializing for the target device.

3.2 Software flash process

Once the Memtool is initialized the flash process itself is quite simple. Before starting please make sure that the DEMO-ENABLE-PLUG is not connected.

- Start the Infineon Memtool on your computer.
- Connect the DAP miniWiggler to Logicboard (position see Figure 3)
- Power up the Evaluation kit (typ 14V)

- Target: Connect (1).
- File: Open (2). Select latest .hex software file.
- File: Select All (3).
- File: Add Selected Sections (4).
- Device: Programm (5).
- Target: Disconnect (6).

- Disconnect the DAP miniWiggler
- Power reset the evaluation kit

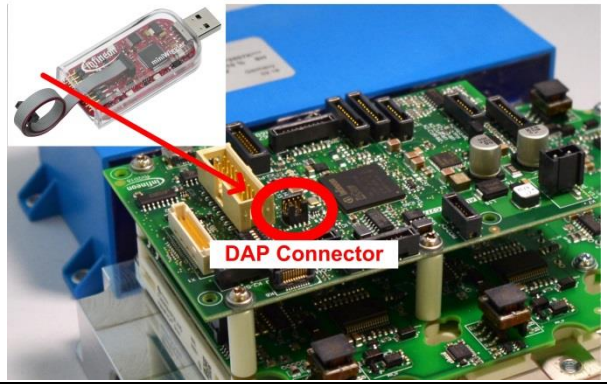


Figure 3 DAP miniWiggler and connector typical position on the evaluation kit.

Figure 4 illustrates the required steps on the Memtool GUI.

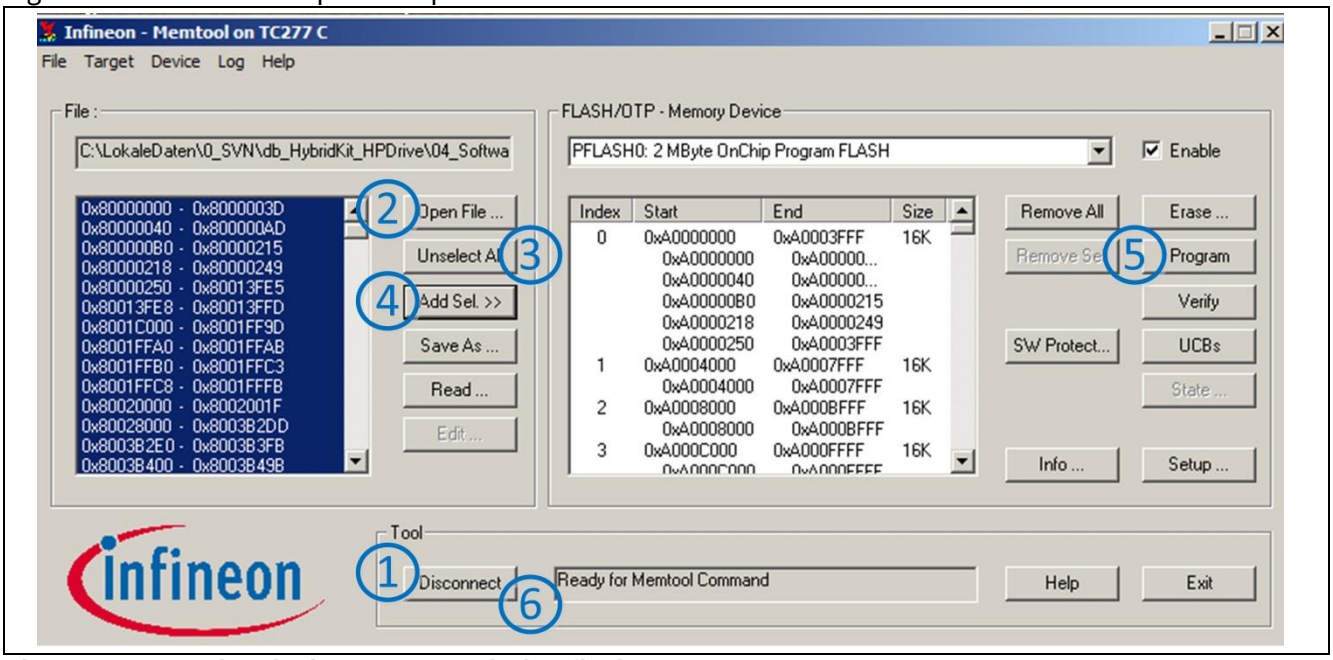


Figure 4 Memtool typical appearance during flash process.

4 Communication via USB/RS232 Terminal Program

Using first time the USB/RS232 communication may require installation of the FTDI USB driver on the PC. Please see section 4.4 for more information. After installation the connection can be established with the following procedure.

After the USB cable is connected from the PC to the evaluation kit (14V supply required) a terminal program (e.g. Tera Term) has to be started. Typically the COM port with the highest number is used for the communication as shown in the example of Figure 5.

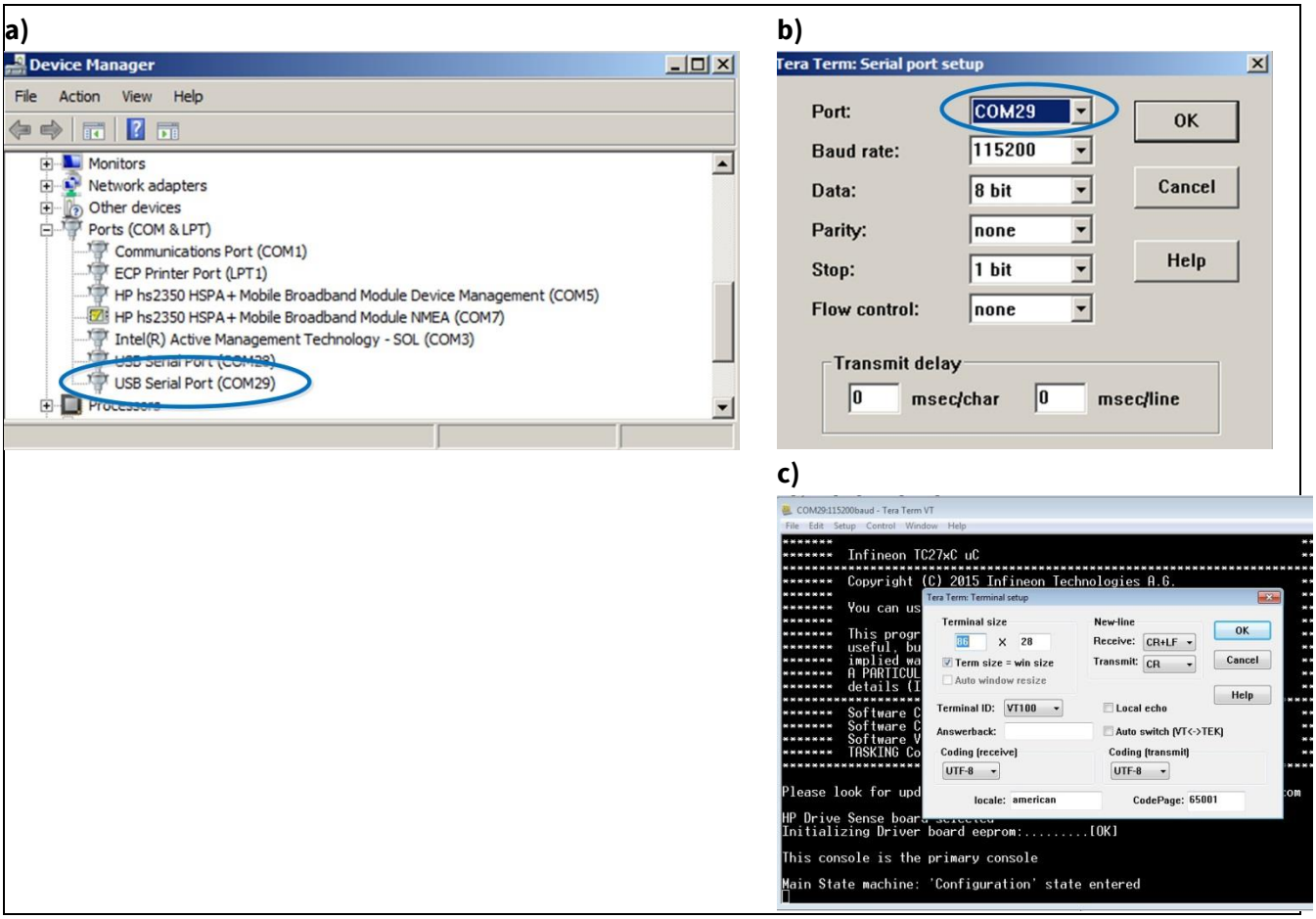


Figure 5 Example Windows device manager with the installed USB to RS232 COM driver (a). Serial port setup example in Tera Term (b). Terminal New-line setting (c).

After the terminal program is connected it is recommended to power reset (toggle) the evaluation kit. In case following text appear please type in “setup console asc0” in order to set the USB serial communication to the default communication protocol:
Shell> Primary console is CAN0
To set this console as primary console enter the command '**setup console asc0**'
A power reset (toggle) may be required after this command and then following text as shown in Figure 6 will appear and now new configuration parameters can be applied to the evaluation kit.

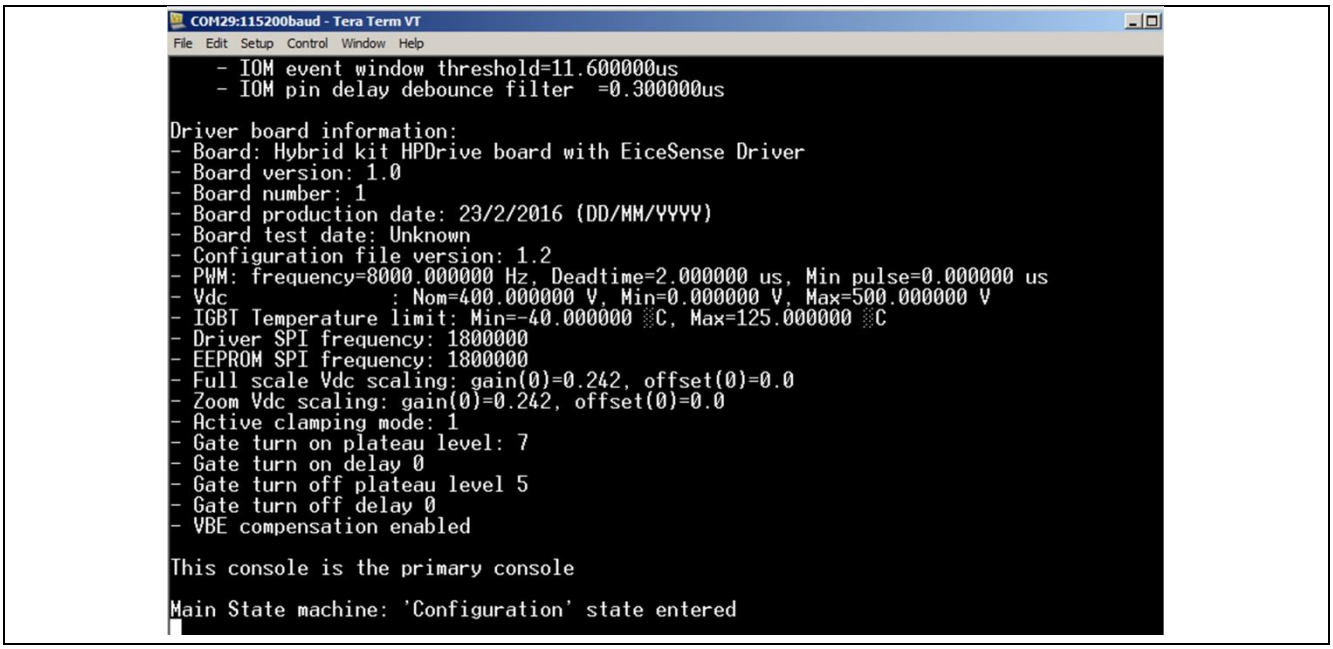


Figure 6 Typcial appearance, when terminal program is connected right and evaluation kit was power toggled. The evaluation kit enters automatically the "Configuration State" (please ensure that DEMO-ENABLE-PLUG is not connected.

4.1 Parameter Configuration of the Evaluation Kit

Please note that the parameters configuration can be performed only when the evaluation kit has entered the "Configuration Mode". The easiest way to enter this state is to remove the DEMO-ENABLE-PLUG and to power toggle the evaluation kit. A short list of the most relevant commands for parameter configuration is given in Table 1. After applying a new parameter set to the evaluation kit it is recommended to type the command "*setup print*" and crosscheck if the new parameters were accepted.

After the parameters were adjusted the DEMO-ENABLE-PLUG can be reconnected. At next power toggle the evaluation kit will start with the new adjusted parameters and the easiest way to control the evaluation kit without any need of a communication (i.e. DEMO-MODE) is now operating with the new parameter set.

With communication it is also possible to printout the setup and the operating conditions (status) during an operation in the DEMO-MODE, which can be very useful for documentation of evaluation measurements. Please note that the communication may fail during high voltage and/or high current tests.

Table 1 Short list of most relevant commands for parameter configuration

Parameter	Command	Example Parameter	Example Command
PWM Frequency	setup db frequency <Hz>	6kHz PWM	setup db frequency 6000
PWM Dead Time	setup db deadtime <s>	1us PWM Signal Dead Time	setup db deadtime 0.000001
TwoLevelTurn-On	setup db twolevelon <level> <delay>	TwoLevelTurnOn Level 5 (approx 10Vge) Delay 25 (approx 1.6us)	setup db twolevelon 5 25
TwoLevelTurn-Off	setup db twoleveloff <level> <delay>		
Maximum Working Voltage (Stop Operation)	setup db vdcmax <V>	Stop >475Vdc working voltage	setup db vdcmax 475

Table 2 Short list of commands printing out the evaluation kit status.

Command	Description
setup print	Prints the current setup like switching frequency, PWM dead times, two level turn on settings, etc. This printout can be used for documentation oft he applied system setup during specific measurements
status	(in DEMO MODE) Prints the current status like measured DC-link voltage, NTC temperarures, modulation Index, output frequency This printout can be used for documentation of the applied operating point during specific inverter steady state measurements

4.2 Open Loop Inverter Operation

After the communication via terminal program is setup it is also possible to start an open loop inverter operation without using the DEMO mode. After power up the system it is started automatically in the configuration mode. This mode can be left by typing:

config exit

Now the evaluation kit is in the 'Run' state and waits for an operation request.
The open loop operation can now be entererd by typing:

mode open

The inverter is ready to be started:

start

The inverter is switching with the defined switching frequency at zero modulation index and zero output frequency.
The output frequency can be adjusted with:

speed <rpm> (e.g. ***speed 600***)

The output frequency is $f_{out}[Hz] = \frac{speed[rpm] \cdot n_{motor_pole_pair}}{60\frac{[rpm]}{[Hz]}}$, whereby the motor pole pair parameter can be seen with the command '*motor print*' and can be also adjusted in the configuration mode before starting operation with the command '*motor pole <n>*' where n is the motor poles.
The output voltage can be adjusted with the amplitude command and adjust the modulation index:

amplitude <m>

From 0 to 84 the SVM is in the normal operation area and from 85 to 100 the overmodulation area can be reached.
The inverter operation can be stopped with command

stop

Please note that during open loop inverter operation the command ***'status'*** do not output correct speed, position or current values in case these sensors are not connected.
Please take note, that in case of a communication failure (e.g. high voltage and/or high current tests) the inverter cannot be stopped with the stop command! In case such tests are planned it is better to apply first a specific parameter set and to start the inverter operation. Then the USB cable can be removed and the inverter continues the operation with the applied parameters. After the PC is disconnected the high voltage source can be activated and the test can be performed. The operation can be stopped by disconnecting the auxillary 14V supply from the logic board.

4.3 Phase Current Sensor Setup

The evaluation kit can be operated also with a phase current sensor. Before using specific sensors or the LEM sensor HAH3DR 800, which is implemented in the HybridKit Drive Sense, it is required to configurate it properly. The configuration can be done after power up the evaluation kit with the commands listed in Table 3 (do not use the DEMO-ENABLE-PLUG). After the configuration is done please type 'config exit' and power toggle the evaluation kit. The configuration is permanent stored in the eeprom. It is recommended to test the configuration with a small defined DC current and the command 'status' in an operation mode before starting with further investigations.

Table 3 Commands for configuration of phase current sensor

Parameter	Command	Example Command for LEM Sensor HAH3DR 800 used in HybridKIT Drive Sense
Sensor gain in A/V	setup m0 current gain <gain>	setup m0 current gain 400
Error threshold in A	setup m0 current max <max>	setup m0 current max 700
Sensor offset in V	setup m0 current offset <offset>	Use default (setup m0 current gain 2.5)
Cut off frequency in Hz	setup m0 current digfilter <cut off frequency>	Use default values
Sensor input filter. Range ={rc, active}	setup m0 current filter <filter>	Use default values

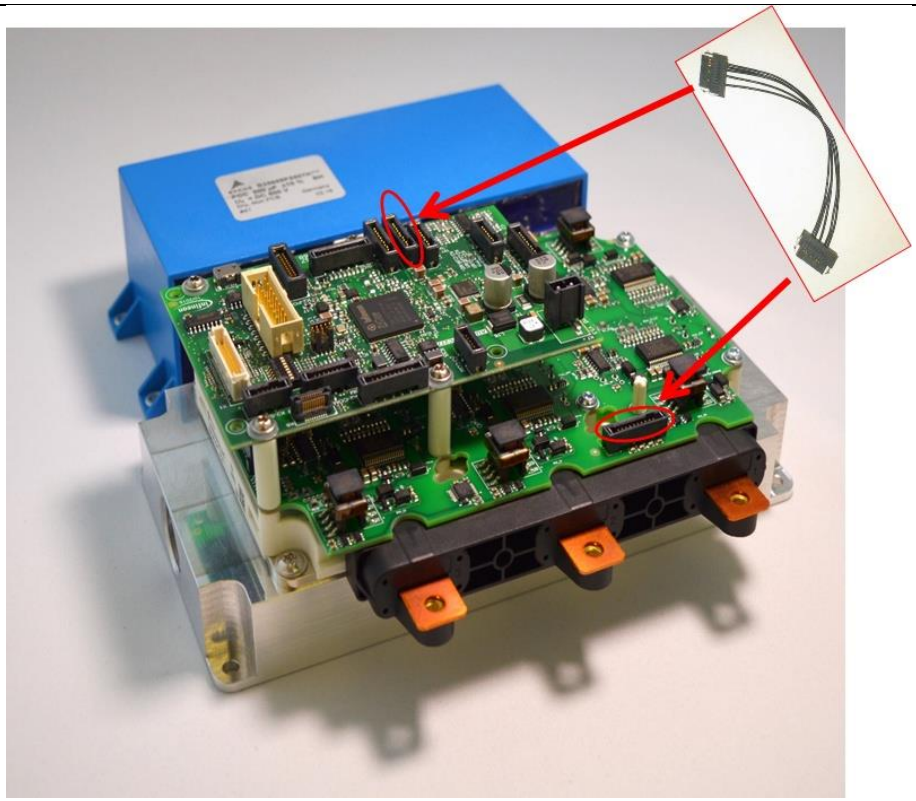


Figure 7 HybridKit Drive Sense and right connection of the phase current sensor cable.

IMPORTANT ERRATA NOTE (for driver boards up to version Sense_V1.1)

Please note that on gate driver board revision ‘Sense_V1.0’ & ‘Sense_V1.1’ the pinning was designed wrong for the LEM Sensor. As the sensor is connected externally with the Samtec connector the pinning can be easily adjusted as shown in Figure 8.

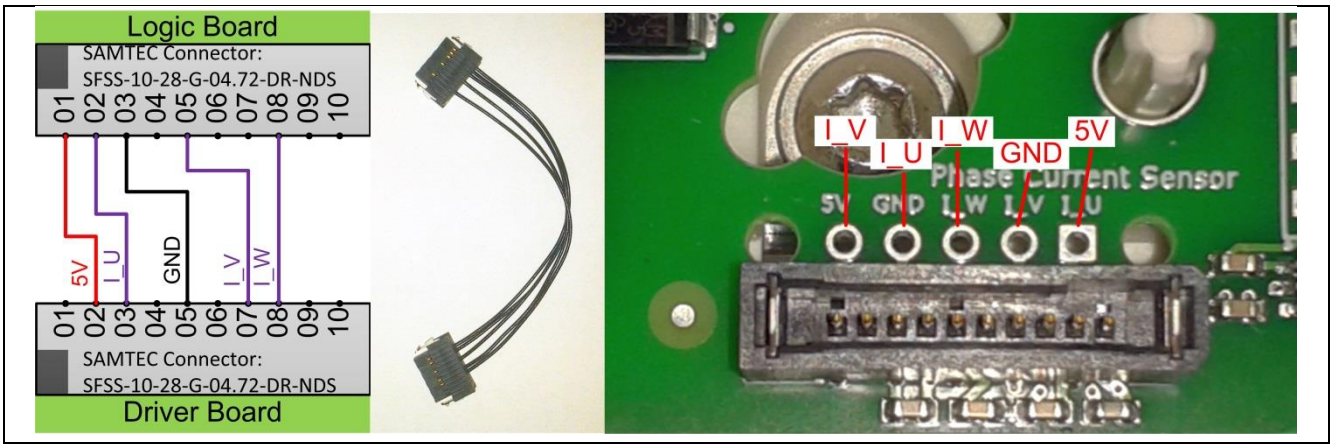


Figure 8 Errata Sensor Connection on HybridKit Drive Sense. Gate Driver Board Revision ‘Sense_V1.0’ & ‘Sense_V1.1’. Please adjust the samtec connector as shown in the picture.

4.4 FTDI USB Driver installation

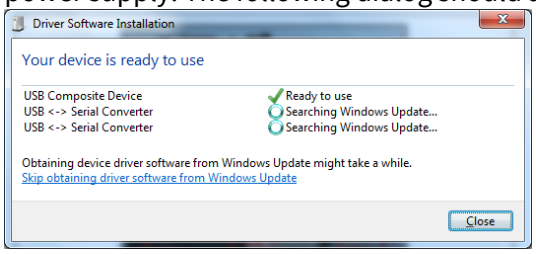
The description is shown based on a standard Windows system and can be different on other operating systems. Please see installation guides at the FTDI Chip website for more detailed information.

Download and install USB driver from http://www.ftdichip.com/Drivers/VCP.htm

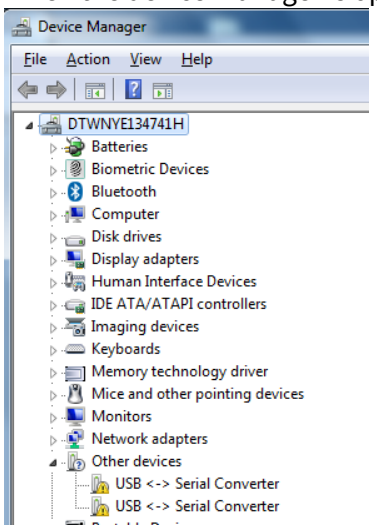
		Processor Architecture							
Operating System	Release Date	x86 (32-bit)	x64 (64-bit)	PPC	ARM	MIPSII	MIPSIV	SH4	Comments
Windows*	2016-02-02	2.12.14	2.12.14	-	-	-	-	-	WHQL Certified. Includes VCP and D2XX. Available as a setup executable Please read the Release Notes and Installation Guides.

Download and run Windows setup executable

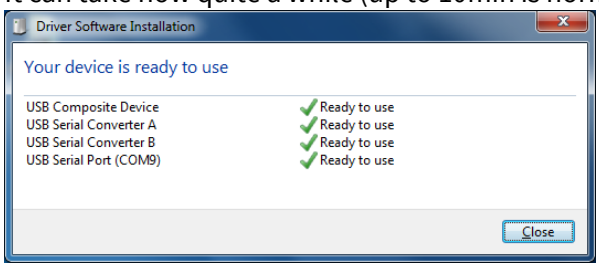
Now connect the evaluation kit to the PC via the USB cable and power up the evaluation kit with the 8..18V power supply. The following dialog should appear:



When the device manager is opened USB <-> serial converters should appear in the devices



It can take now quite a while (up to 10min is normal) until the driver is finally installed.



For trouble shooting at USB driver installation please consult:
http://www.ftdichip.com/Support/Documents/InstallGuides.htm

5 Initial Parameter Setting of a new Evaluation Kit

The Evaluation Kits come with pre-installed software and default parameter setting is already done and tested at the Evaluation Kit production partner. This enables a plug and play operation for customers.
In case of repair purpose or when parts of the evaluation kits are replaced by hardware of a newer status it is sometimes necessary to apply after software flashing new parameter setting into the evaluation kit.
The following table can be a simple guideline. The full software documentation can be found in 7.3.

Example Commands **set correct values/dates**	Explanation	
setup unlock	setup unlock	
setup lb version 3 3	setup lb version <version> <revision>	set logic board version
Power cycle the board	Power cycle the board	
setup unlock	setup unlock	
setup lb number 1	setup lb number <no>	Set logic board number, optional
setup lb date 2017 10 17	setup lb date <year> <month> <day>	Set logic board production date, optional
setup db version dbhpdsense 1 2	setup db version <boardname> <version> <revision>	set driver board version
setup db number 1	setup db number <no>	Set driver board number
setup db date 2016 10 17	setup db date <year> <month> <day>	set driver board production date
setup reset	setup reset	Set the EEPROM parameter to default
	setup print	Show the setup

6 Double Pulse Testing

With the USB/RS232 terminal it is very convenient to adjust gate driver settings like two-level turn-on and two-level turn-off. For a deeper investigation of the corresponding switching characteristics it is sometimes useful to perform double pulse tests rather than inverter tests. Such tests can be easily performed by using the following sequence:

1. Turn-off all power supplies
2. Remove DEMO-ENABLE Plug
3. Connect the PC via terminal program and USB
4. Turn-on the 14V auxillary supply
5. Configurate parameters (see section 4.1)
6. Check if parameters are applied (command ‘setup print’)
7. Apply DEMO-ENABLE plug and **Remove USB Cable**
8. Turn-off and on the 14V auxillary supply
9. Turn-on the high voltage source and perform double pulse tests

When the DEMO-ENABLE Plug is connected, but the DEMO-CONTROL plug still missing (or both potis to high position), the evaluation kit configurates the drivers and settings in default configuration and is afterwards waiting in the run mode. In this status the gate drivers are properly configurated but no PWM pulses are driven as the start condition (poti low position on the DEMO-CONTROL-plug) is not detected. Thus, the pre-configuration can be utilized and the gate drivers can be pulsed from an external pulse generator. In this case the signal from the logic board is overruled. For this purpose SMD single pin connectors are implemented on the evaluation gate driver board as shown in Figure 9.

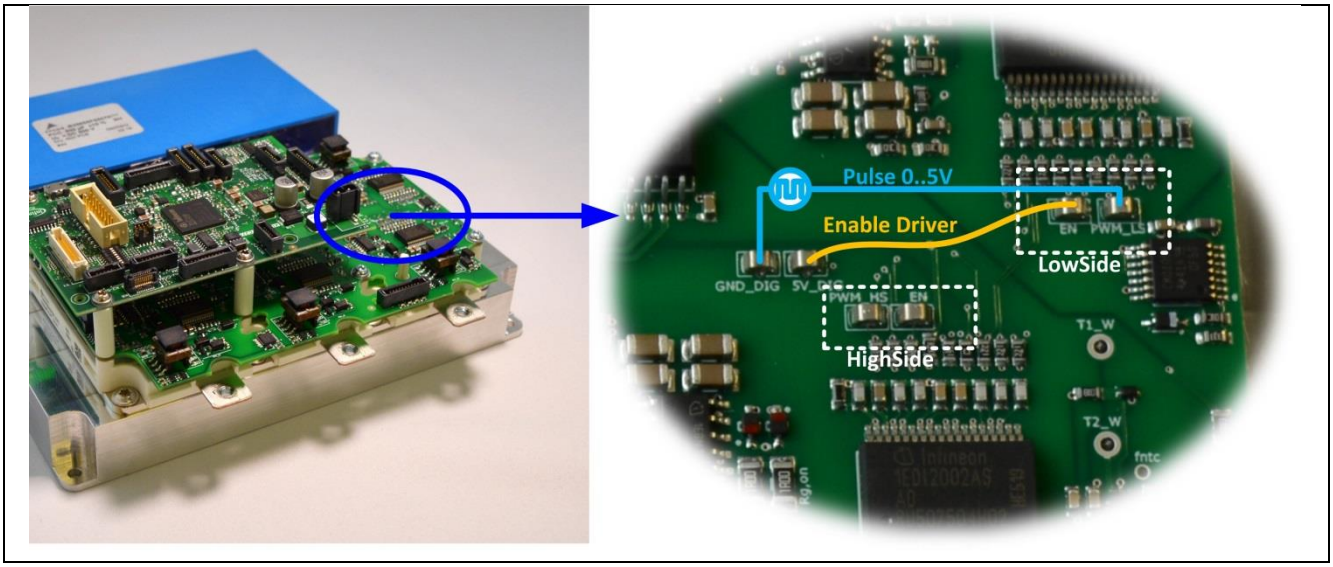


Figure 9 Example how testpads on the gate driver board can be utilized for double pulse tests.

7 Troubleshooting Guide and Frequently Asked Questions

7.1 Connection Problems via USB/RS232

Please note that USB/RS232 communication method is not well suited for noisy lab environments and thus the connection may fail during high voltage and/or high current tests. **Before running tests at higher voltages and or currents it is recommended to disconnect the USB cable.** The communication via USB/RS232 should be understood as a simple feature to setup system parameters but it is not intended to monitor data during load tests. The communication via USB/RS232 also strongly depend on the USB cable quality and length as well as the computer itself. Customers feedback showed that Micro USB cables Nylon 1m from Rampow™ lead to quite stable USB communication.
For monitoring a CAN communication is recommended.

7.2 CAN Bus Communication

It is also possible to communicate with the evaluation kit via CAN bus. The required cable configuration can be seen in Figure 10. For definition of the CAN messages please take a look in the doxygen software documentation on the CD (see section 7.3).
Recommended is an PCAN-USB opto-decoupled, because its divers are compatible with the OneEye GUI provided on the CD.

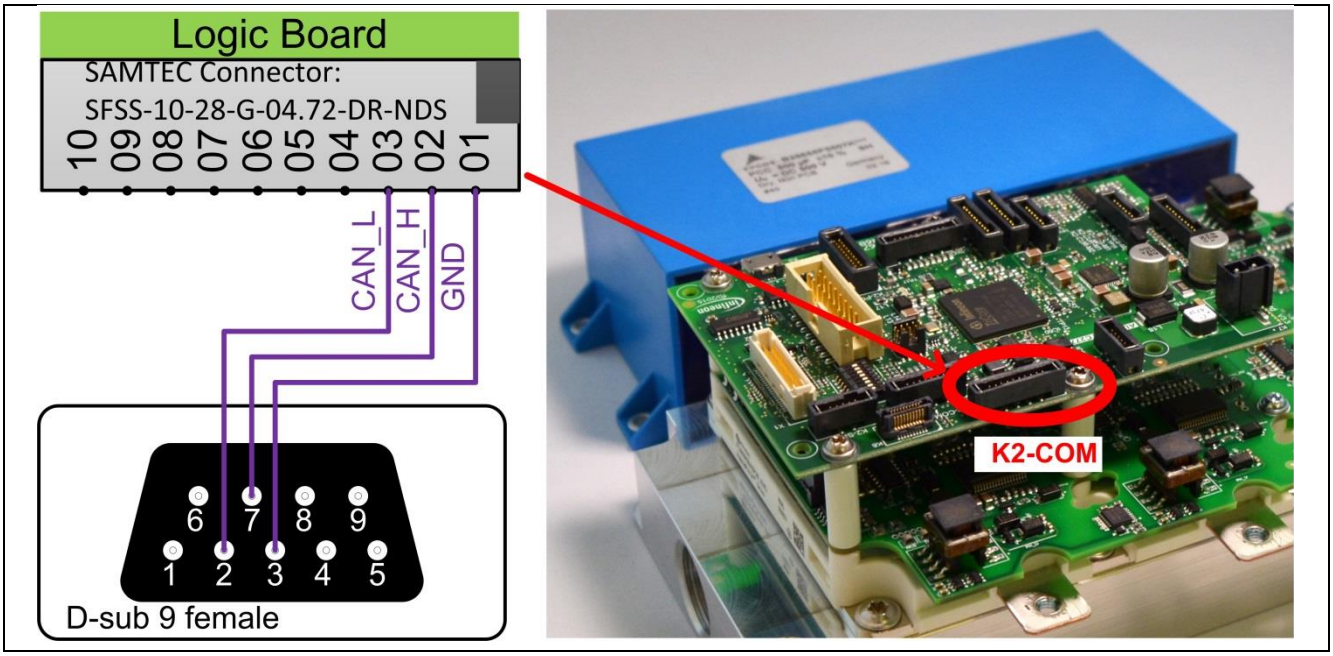


Figure 10 Example for connecting via CAN bus communication.

7.3 Where can I find full software documentation

The full documentation of the software can be found on the CD, which is included in the shipping content:
\SW\<SW Version>\3_Doc\Doxygen\Out\<SW Version>.chm

8 References and Revision History

The referenced application notes can be found at http://www.infineon.com

[1] Infineon Application Note AN-HPD-ASSEMBLY, “Assembly Instructions for the HybridPACK Drive”.

[2] Infineon Application Note AN-HPD-QUICKSTART, “HybridKit Drive Quickstart Manual”.

Revision History

Date	Version	Changed By	Change Description
2016-04	0.9	Tomas Reiter (IFAG ATV HP EDT MD)	Initial Beta Version
2017-02	1.0	T. Reiter	Minor corrections and updated pictures. Added FTDI chip usb driver installation.
2017-10	1.1	T. Reiter	Added pictures and more detailed descriptions.

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AN-HPDKIT-ADVANCED-FEATURES

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