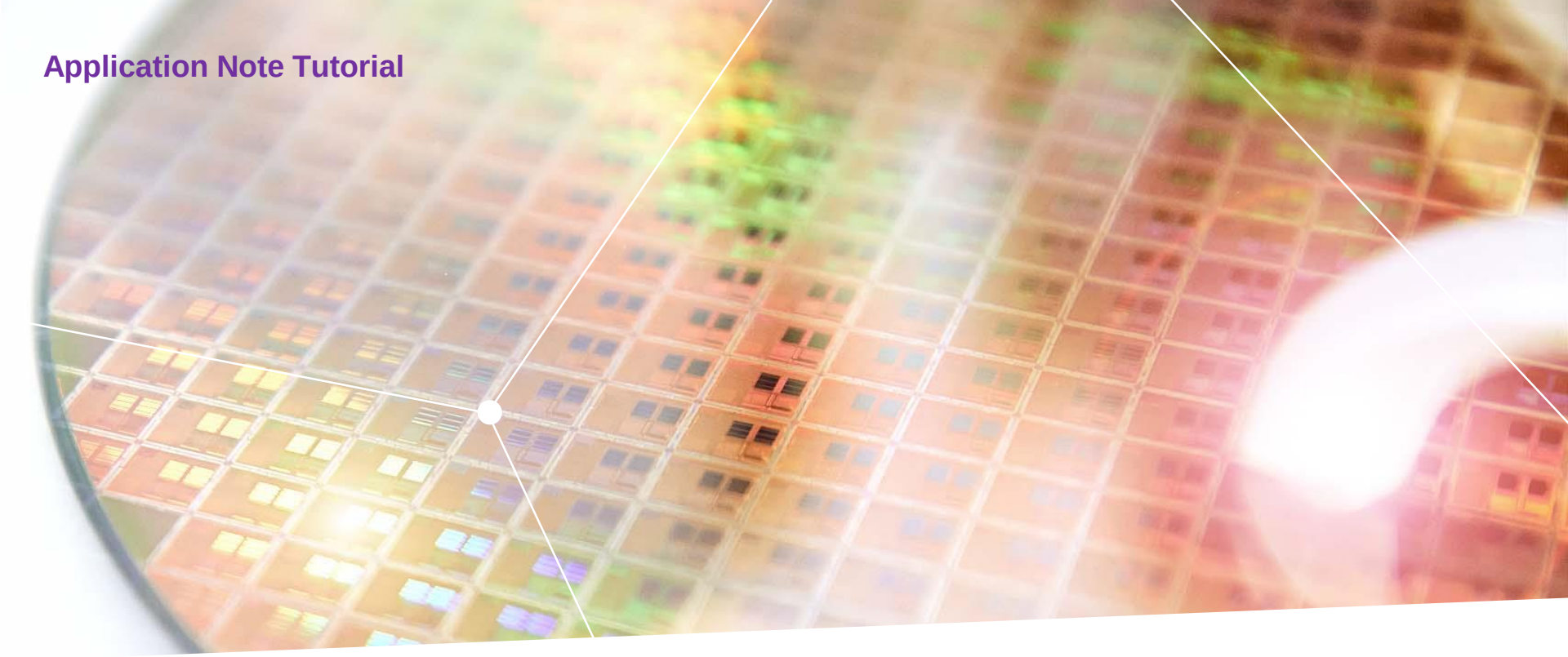
Application Note Tutorial



AURIX™ TC3xx Motor Control Application Kit Getting Started

AP32542
v1.0

Please read the Important Notice and Warnings at the end of this document

About this document

Scope and purpose

- This tutorial describes the content of AURIX™ TC3xx Motor Control Application Kit and explain instructions to get it running
- This document is valid for AURIX™ TC3xx Family
- Validated on AURIX™ TC387-A-Step

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1 AURIX™ TC3xx Motor Control Application Kit Overview

2 AURIX™ TC3xx Motor Control Power Board

3 Motor and Incremental Encoder

4 AURIX™ TC387 Application Kit with TFT

5 AURIX™ TC3xx PMSM FOC Motor Control Software

6 Run motor

7 Acronyms, references, revision history

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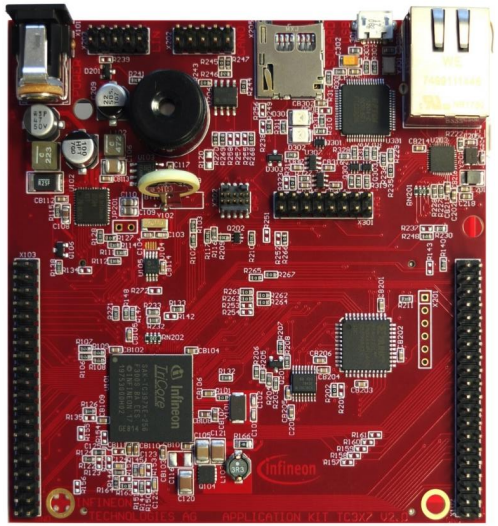
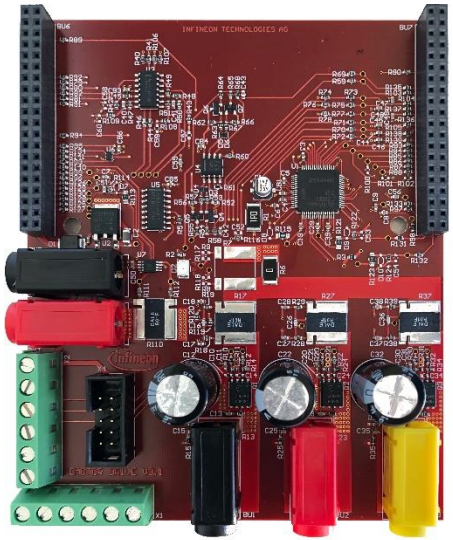
AURIX™ TC3xx Motor Control Application Kit Overview

- AURIX™ TC387 Application Kit with TFT

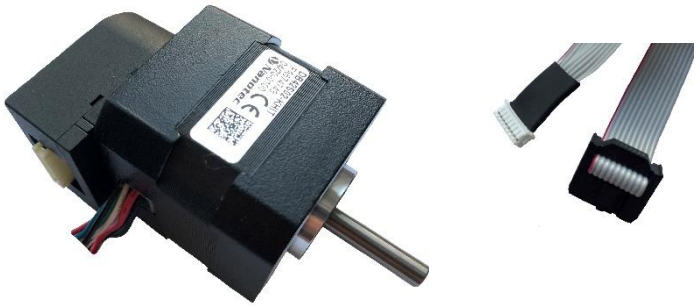


- AURIX™ TC3xx Motor Control Power Board



- Power Supply Adapter Sunny SYS1541-2412:12V, 2A (plugs USA, UK, EU)

- NANOTEC DB42S02-KHIT with WEDL5541-B14-KIT encoder



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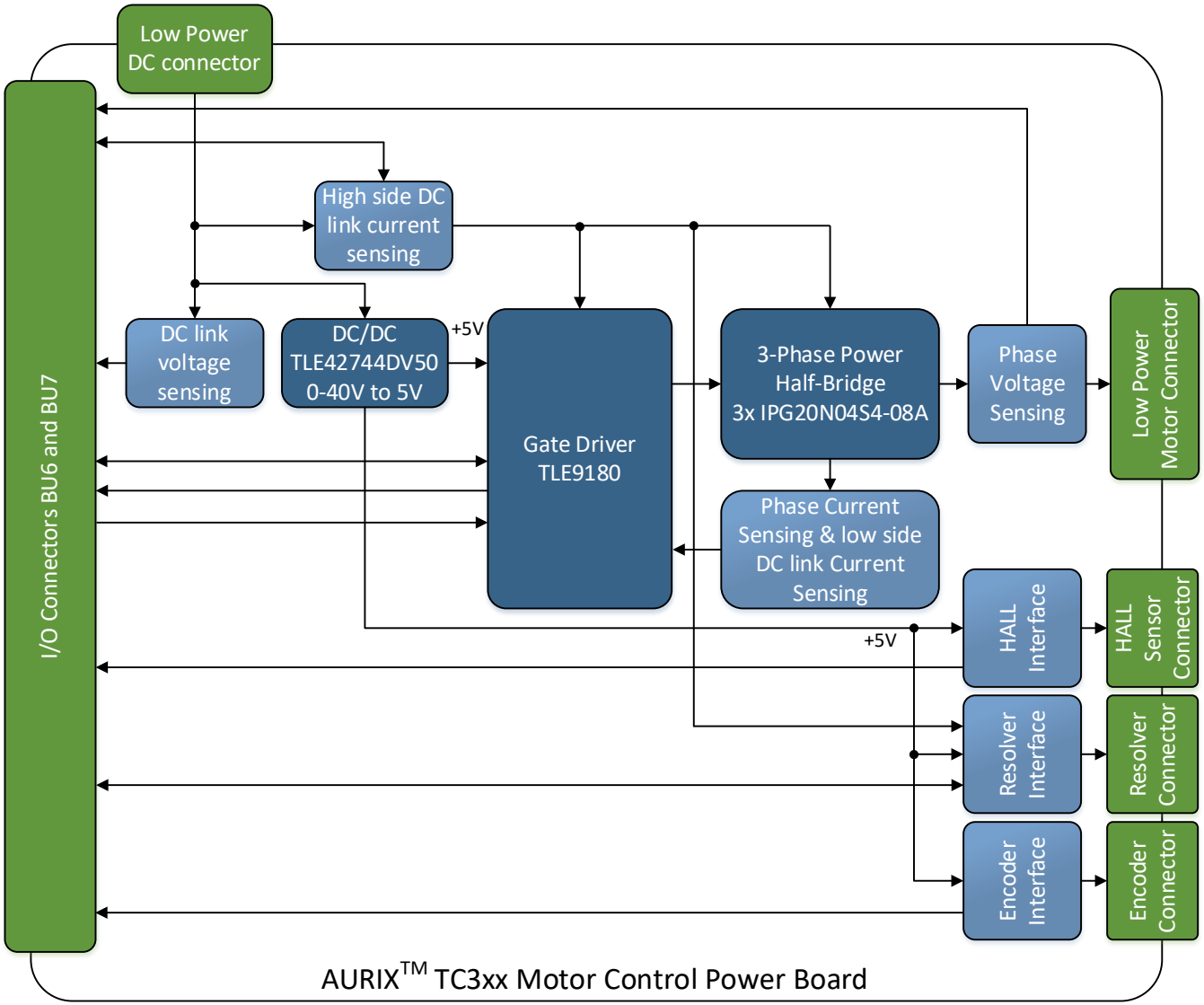
AURIX™ TC3xx Motor Control Power Board Block Diagram



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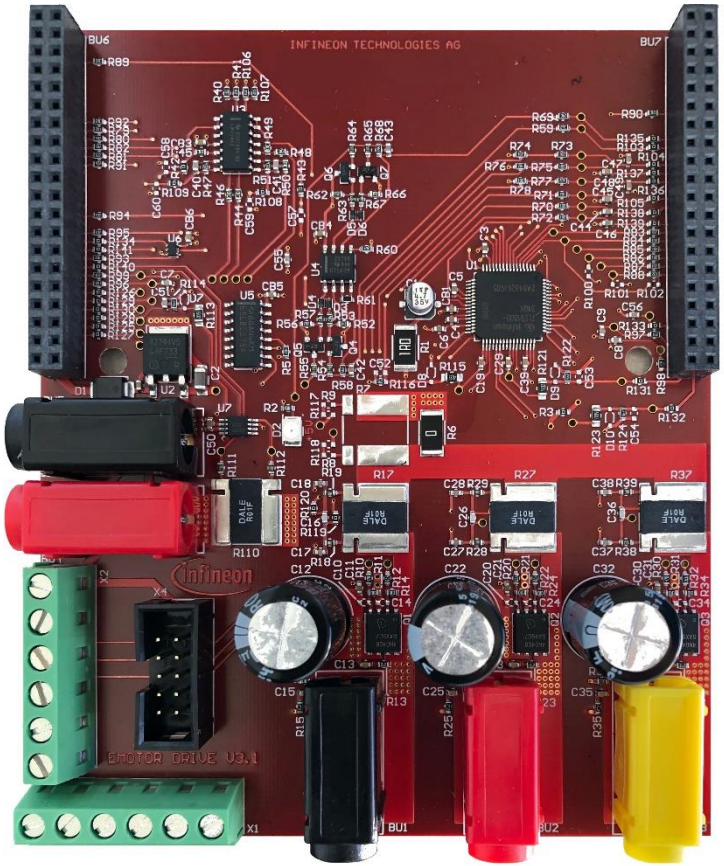
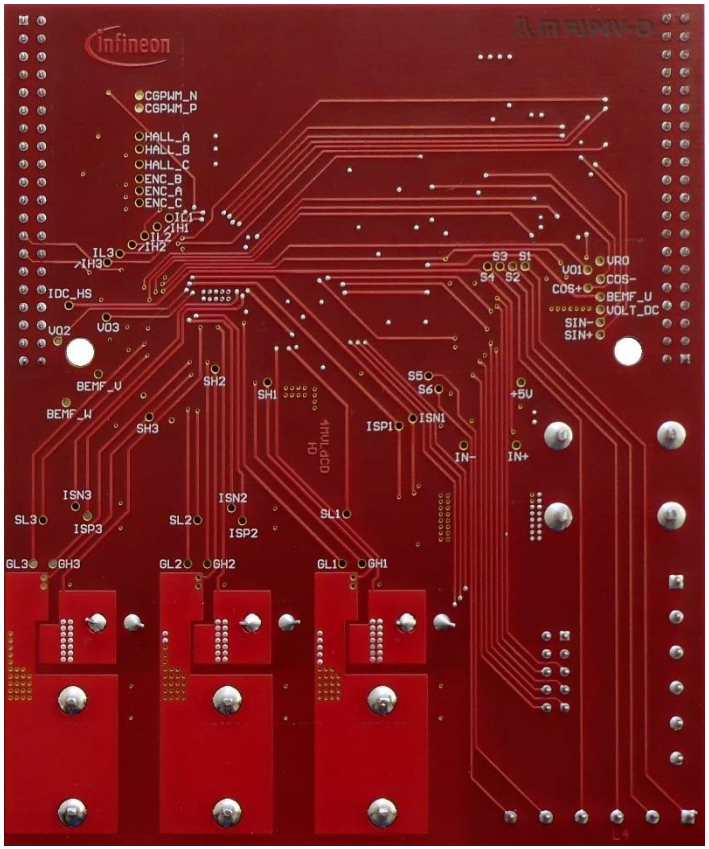
AURIX™ TC3xx Motor Control Power Board
Top and Bottom View

› Top View



› Bottom View



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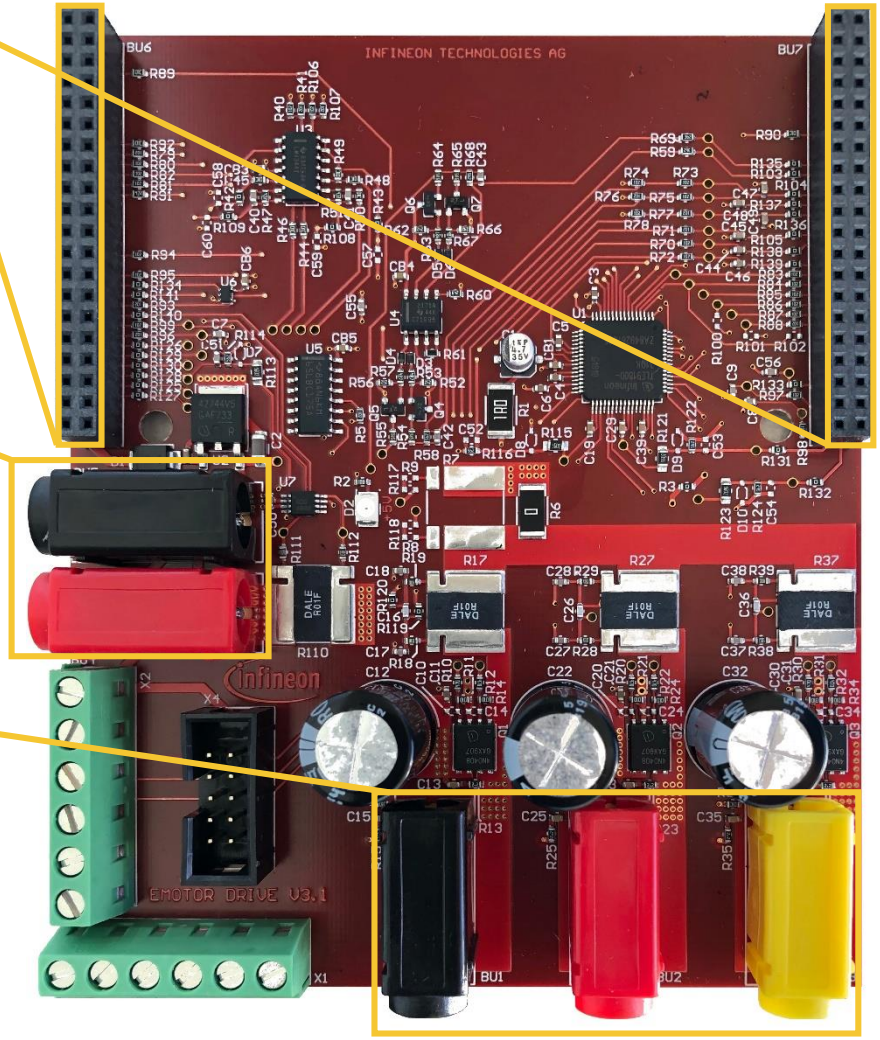
AURIX™ TC3xx Motor Control Power Board Connectors

- Connection with AURIX™ TC3xx Application Kit with TFT
  - BU6 Connector: 40 Pins
  - BU7 Connector: 40 Pins

- Power Supply Connectors
  Color Coding:
  - Black: Ground (GND)
  - Red: +12V (VBAT)

- Motor Connectors
  Color Coding:
  - Black: Phase U
  - Red: Phase V
  - Yellow: Phase W



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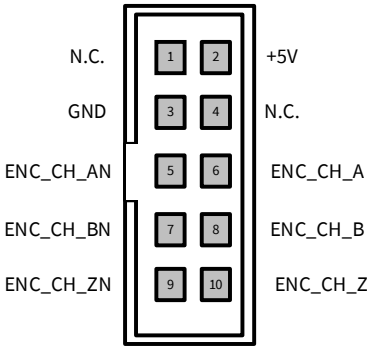
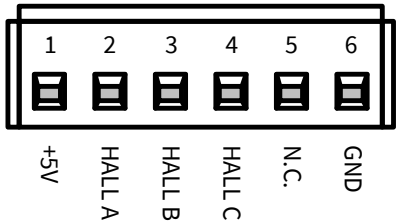
AURIX™ TC3xx Motor Control Power Board Connectors

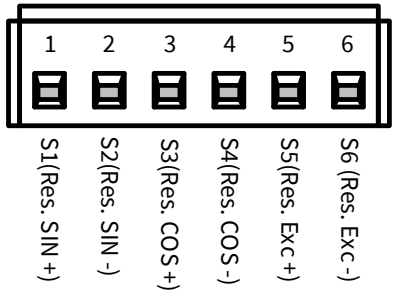
› Incremental encoder connector

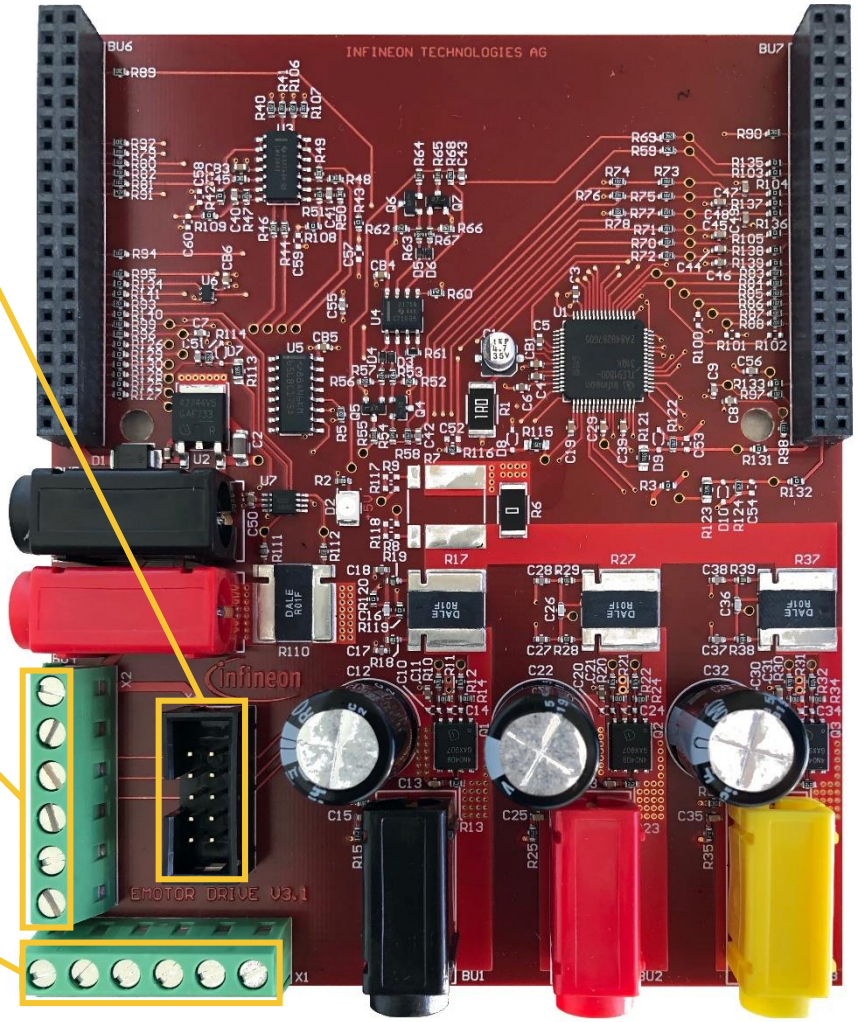


› Hall sensors connector



› Resolver connector





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› BU6 and BU7 Pinout

BU6 connected to App. Kit with TFT X102 connector

N.C.	39	40	N.C.
N.C.	37	38	/SOFF
N.C.	35	36	N.C.
N.C.	33	34	N.C.
/ERR	31	32	N.C.
CSN	29	30	CLK_SPI
MOSI	27	28	MISO
N.C.	25	26	ENA
N.C.	23	24	N.C.
N.C.	21	22	N.C.
N.C.	19	20	PFB2
PFB1_Enable	17	18	PFB3
N.C.	15	16	GS0_HS
PFB1	13	14	GS1_HS
VRO	11	12	VO1
COS- (VCC/2)	9	10	COS+
BEMF_U	7	8	VOLT_DC
SIN- (VCC/2)	5	6	SIN+
GND	3	4	GND
VCC_IN	1	2	VEXTA

BU7 connected to App. Kit with TFT X103 connector

VEXTB	2	1	VCC_IN
GND	4	3	GND
N.C.	6	5	N.C.
N.C.	8	7	N.C.
/INH	10	9	N.C.
N.C.	12	11	N.C.
CGPWM_P(Prim.Coil)	14	13	CGPWM_N(Prim.Coil)
HALL A	16	15	N.C.
HALL_C	18	17	HALL_B
ENC_B	20	19	ENC_A
N.C.	22	21	ENC_C
IL1	24	23	N.C.
IL2	26	25	/IH1
IL3	28	27	/IH2
N.C.	30	29	/IH3
N.C.	32	31	N.C.
N.C.	34	33	N.C.
IDC_HS	36	35	BEMF_V
VO3	38	37	N.C.
VO2	40	39	BEMF_W

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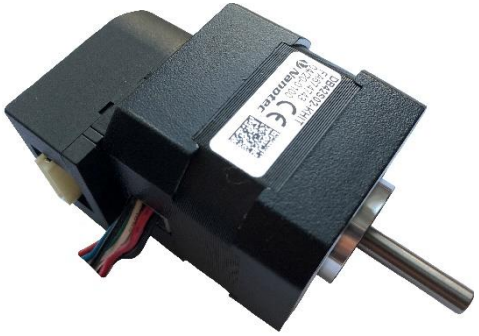
Motor and Incremental Encoder

- Nanotec DB42S02: Electric motor
  - NEMA: 17
  - Rated Power: 42 W
  - No. of Poles/Phase: 8/3
  - Rated Torque: 5 Ncm
  - Rated Current: 3.57 A
  - Rated Speed: 8000 rpm
  - Rotor Inertia: 24 gcm²
  - Line to Line Inductance: 0.25 mH
  - Weight: 0.25 kg
  - Size: 42 mm
  - Rated Voltage (VDC): 17 V
  - Peak Torque: 15 Ncm
  - Peak Current: 10.78 A
  - Torque Constan: t 1.4 Ncm/A
  - Line to Line Resistance: 0.19 Ohm
  - Length: "A" 41 mm



- WEDL5541-B14-KIT (5 mm): Incremental Encoder
  - Index
  - Encoder Signal Type: incremental
  - Shaft Diameter: 5 mm
  - Output Signals phase: A, A\, B, B\, I, I\
  - Limit Frequency: 100 kHz
  - Phase Shift: 90° ± 45°
  - Max. Output Current per Channel: 0 ~ 5 mA
  - Storage Temperature: -40 °C - 100 °C
  - Line: Driver
  - Encoder Resolution: 1000 CPR
  - Operating Voltage (Encoder): 5 V
  - Current Consumption: ≤ 60 mA
  - Limit Speed: 6000 RPM
  - Signal Level: VH 85% VCC, VL ≤ 0.3 V
  - Operating Temperature: -25 °C - 100 °C
  - Humidity: max. 90 % (no condensation)
- ZK-WEDL-8-500: Encoder Cable

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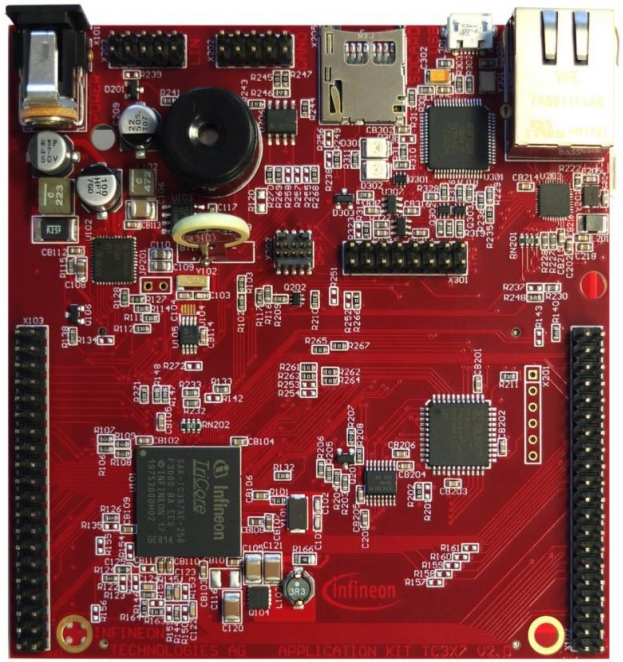
AURIX™ TC387 Application Kit with TFT Overview

› KIT_A2G_TC387_5V_TFT: Components

- Infineon's Multi Voltage Safety Micro Processor Supply TLF35584QV
- LED to validate power supply (5V or 3,3Volt)
- LED indicating RESET (ESR0) active state
- LED indicating active miniWiggler JDS
- LED switched via DAS software
- Infineon's High Speed CAN Transceiver TLE 9251V (CAN FD capable)
- Infineon's LIN-Transceiver TLE 7259-3GE
- QSPI Real-Time Clock/Calendar with SRAM and unique MAC Id MCP79511 (if CPU not support I2C)
- I2C Real-Time Clock/Calendar with SRAM and unique MAC Id MCP79411 (if CPU support I2C)
- USB to UART bridge FT2232HL (FTDI)
- Integrated 10/100/1000M Ethernet Precision Transceiver RTL8211FI-CG (Realtek)
- Touch screen controller ADS7843
- 4 general purpose LEDs – Reset switch
- Wake switch
- Xilinx CPLD XC9572XL



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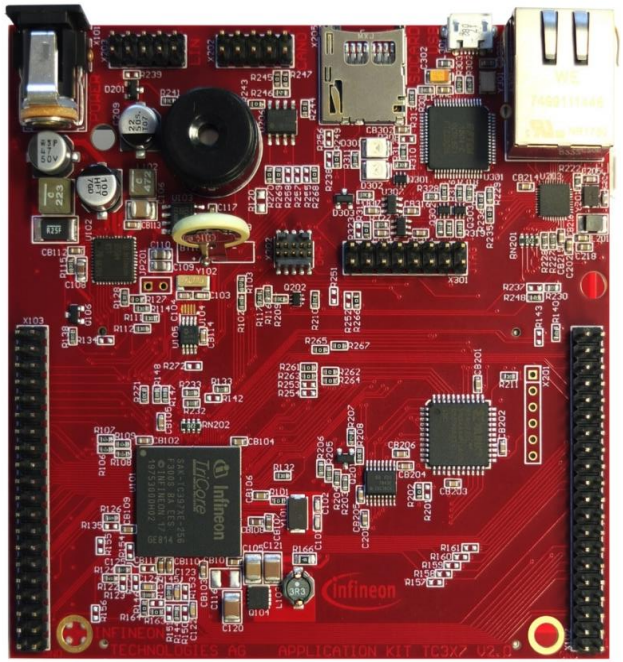
AURIX™ TC387 Application Kit with TFT Overview

› KIT_A2G_TC387_5V_TFT: Connectors

- Standard power connector
- Micro USB connector for ASC Interface (ASC0) and miniWiggler
- RJ45 connector for Ethernet (if Gigabit Ethernet supported by assembled CPU)
- 16-pin header for JTAG interface (OCDS)
- 10-pin header for DAP
- 10-pin (2x5-pin) Header for LIN Transceiver (LIN)
- 10-pin (2x5-pin) Header for CAN High Speed Transceiver (CAN0)
- two 40-pin connectors with I/O signals
- mini SD card slot



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AURIX™ TC387 Application Kit with TFT Overview

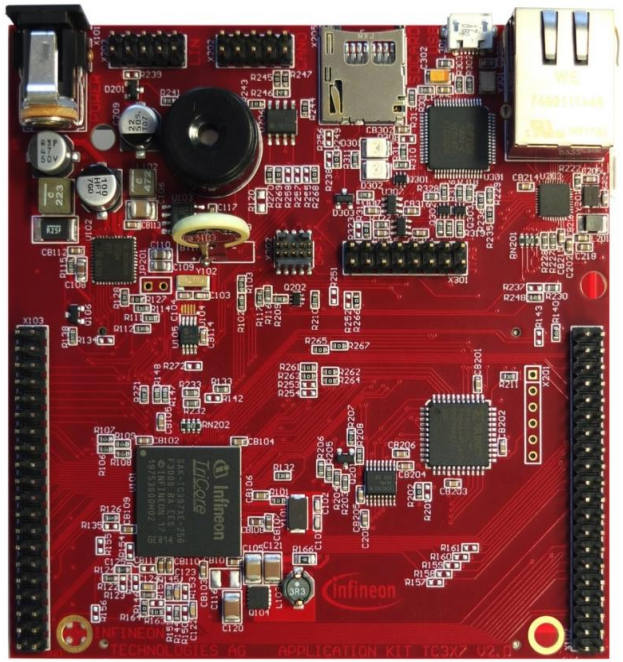
- KIT_A2G_TC387_5V_TFT: IO Connectors Pinout

X103

(VCC_IN)	1	2	V_UC
GND	3	4	GND
P21.2	5	6	P21.3
P14.8	7	8	P14.7
P14.6	9	10	P20.0
P21.4	11	12	P21.5
P02.0	13	14	P02.1
P02.2	15	16	P02.3
P02.4	17	18	P02.5
P02.6	19	20	P02.7
P02.8	21	22	P00.0
P00.1	23	24	P00.2
P00.3	25	26	P00.4
P00.5	27	28	P00.6
P00.7	29	30	P00.8
P00.9	31	32	P00.10
P00.11	33	34	P00.12
AN19	35	36	AN18
AN17	37	38	AN16
AN25	39	40	AN24

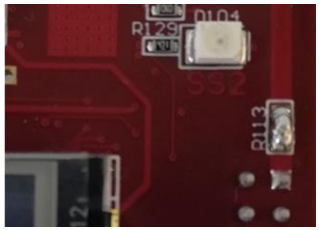
X102

P14.5	40	39	P14.4
P33.10	38	37	P33.9
P15.7	36	35	P15.6
P15.5	34	33	P15.4
P15.8	32	31	P15.2
P22.3	30	29	P22.2
P22.1	28	27	P22.0
P33.11	26	25	P23.4
P23.3	24	23	P23.2
P23.1	22	21	P23.0
P33.6	20	19	P33.8
P33.12	18	17	P33.1
P33.2	16	15	P33.3
P33.4	14	13	P33.5
AN0	12	11	AN8
AN2	10	9	AN3
AN11	8	7	AN13
AN20	6	5	AN21
GND	4	3	GND
V_UC	2	1	(VCC_IN)



- Changes that was required when using with AURIX™ TC387 Motor Control Application Kit

To be able to supply AURIX™ TC387 Application Kit with TFT from power board and run the program, one should solder 0 Ω resistor or just make short circuit on R113.



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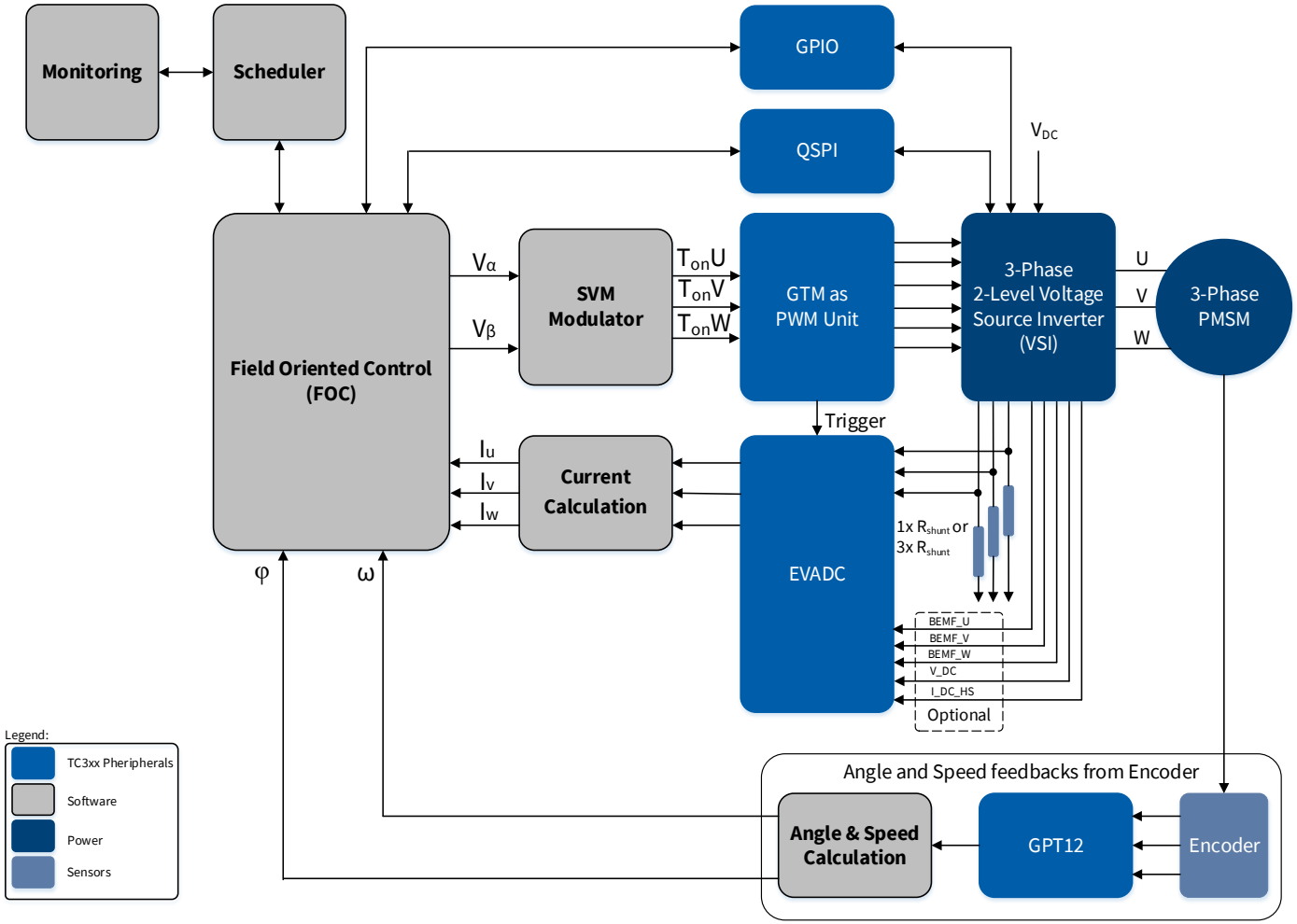
AURIX™ TC3xx Motor Control Software

› System overview



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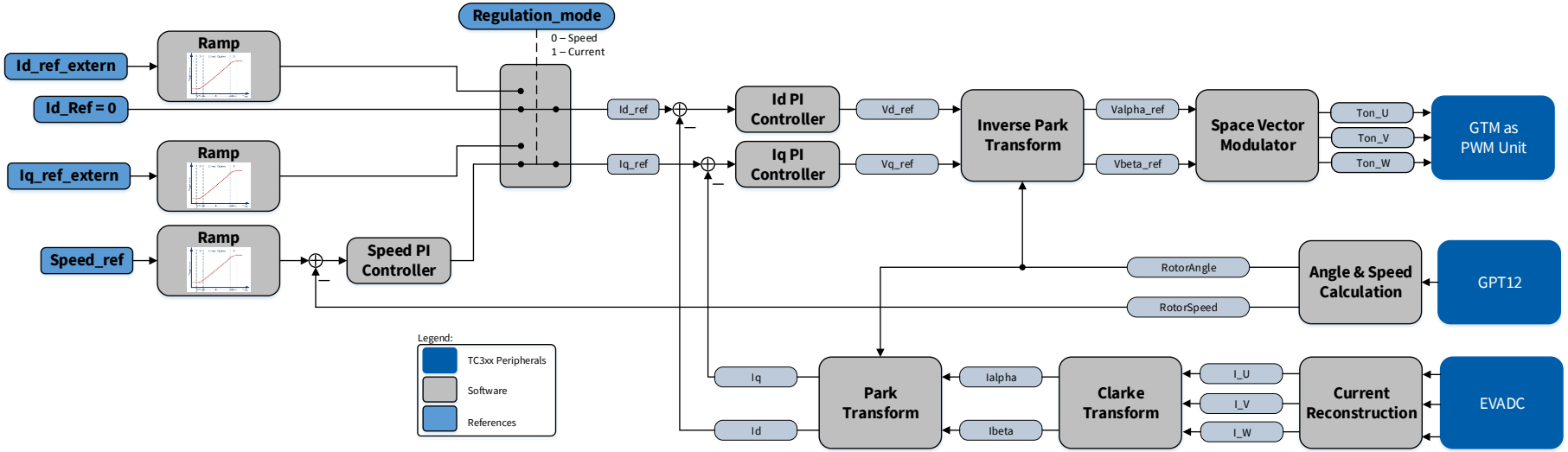
AURIX™ TC3xx Motor Control Software

- Field Oriented Control: controls the stator currents by providing control voltages to the three-phase system.
  - stator DQ current is given as reference to control torque and flux
  - forward path is the three-phase voltages generation
  - feedback paths are the stator currents and rotor position acquisitions



- Regulation mode:
  - Speed (by default): Output of speed regulator is Q-axis current reference, the D-axis current reference is set to 0. Speed can be set by using buttons available on touch screen or manually in debug mode
  - Current: The D- and Q-axis current references could be set manually in debug mode

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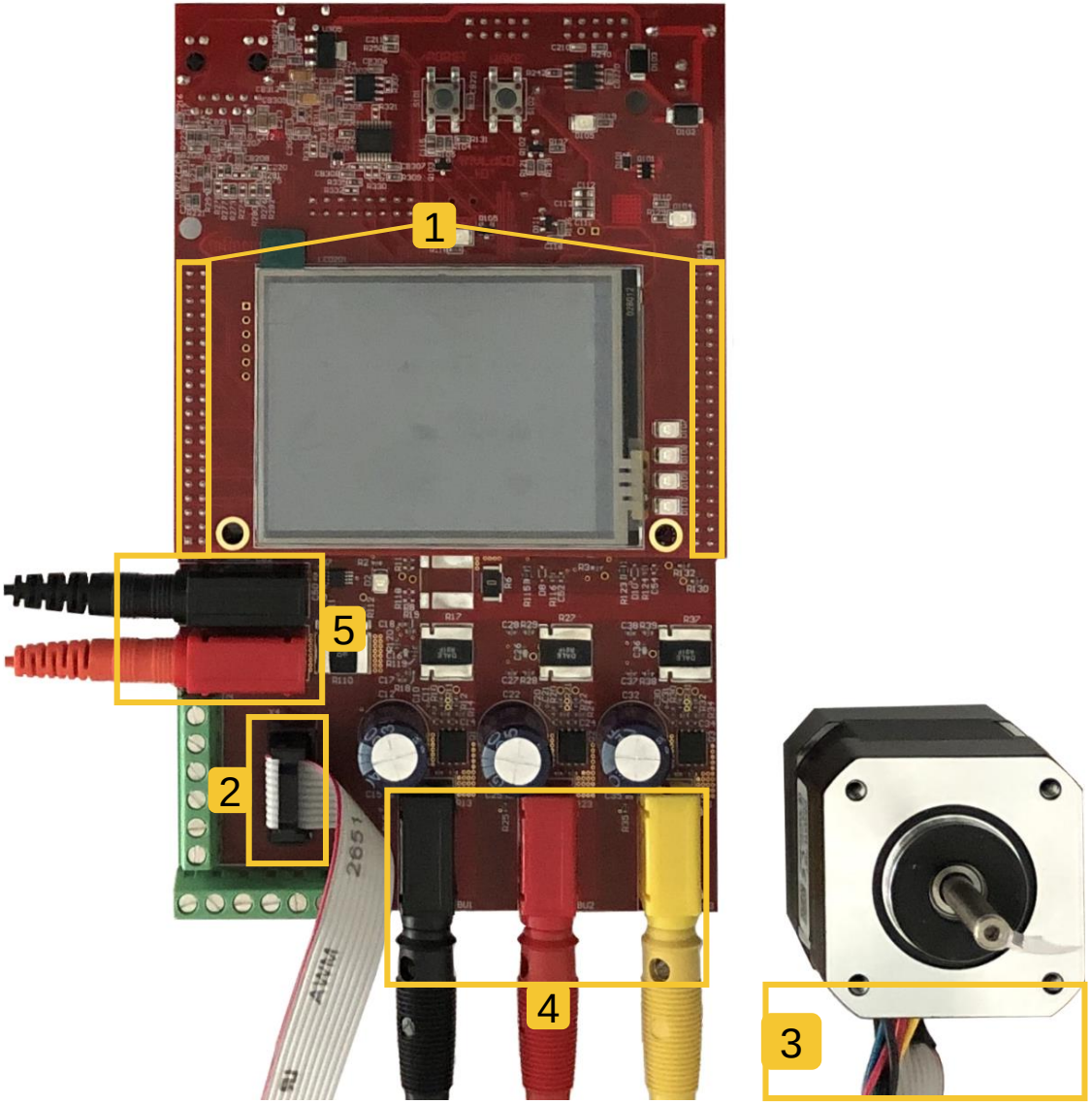
Run motor
Components connecting

1. Connect AURIX™ TC387 Application Kit with TFT (connectors X102 and X103) and power board (connectors BU6 and BU7)
2. Connect one side of encoder cable and power board (connector X4)
3. Connect second side of encoder cable with encoder
4. Connect motor phase connectors and power board (connectors BU1, BU2 and BU3)
5. Connect power supply adapter extension cables and power board (connectors BU4 and BU5)
6. Connect power supply



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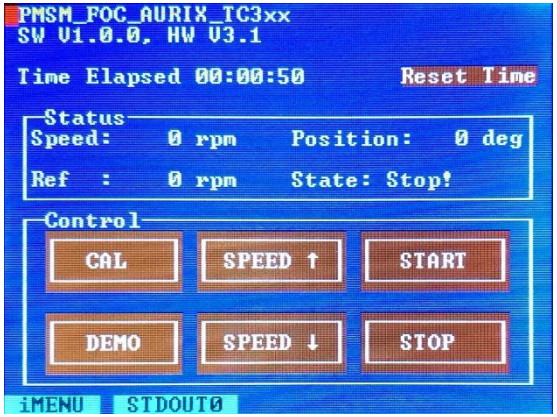
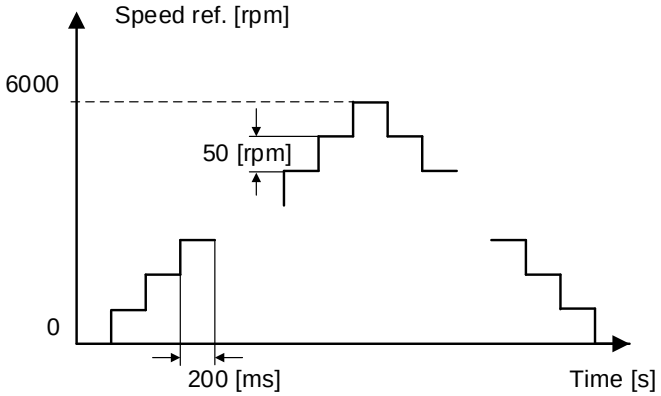
Run motor
Local command set and basic monitoring



Demo cycle: speed reference profile



Page: iMENU

- Software version and corresponding power board
- Time elapsed
- Status
  - Speed: actual rotor speed in rpm
  - Ref: reference speed in rpm
  - Position: actual rotor position measured by position sensor in deg
  - State: Actual control state
- Control
  - CAL: trigger calibration routine
  - DEMO: trigger predefined speed reference profile and start motor
  - SPEED ↑: increase speed reference, 100 rpm step size
  - SPEED ↓: decrease speed reference, 100 rpm step size
  - START: start motor
  - STOP: stop motor

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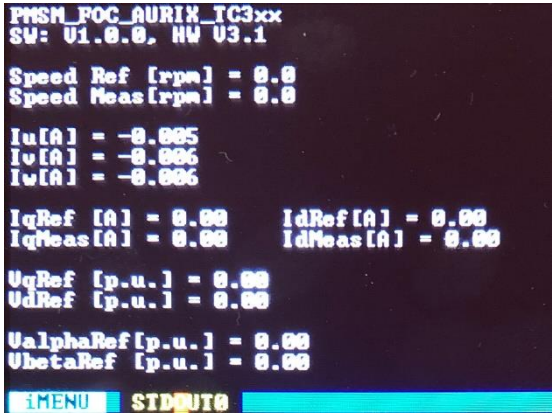
Run motor
Local command set and basic monitoring



Page: STDOUT0

- Software version and corresponding power board
- Speed reference and actual speed
- Phase currents
  - Iu [A]
  - Iv [A]
  - Iw [A]
- D- and Q-axis current references and actual values
  - IdRef [A], IdMeas [A]
  - IqRef [A], IqMeas [A]
- D- and Q-axis voltage reverences
  - VdRef [p.u.]
  - VqRef [p.u.]
- Aβ voltage references
  - ValphaRef [p.u.]
  - VbetaRef [p.u.]

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Acronyms, references, revision history

Acronyms

Term	Definition
EVADC	Enhanced Versatile Analog-to-Digital Converter
FOC	Field Oriented Control
GPIO	General Purpose Input Output
GPT12	General Purpose Timer Unit
GTM	Generic Timer Module
PMSM	Permanent Magnet Synchronous Motor
QSPI	Queued Synchronous Peripheral Interface
SVM	Space Vector Modulation

References

- [1] AP32541 AURIX TC3xx Motor Control Power Board, v1.0
- [2] AP32540 PMSM FOC motor control using AURIX TC3xx, v1.0
- [3] Application Kit TC3x7 User Manual, v2.1
- [4] User Manual AURIX™ TC3xx, revision 1.5

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Acronyms, references, revision history

Revision history

Revision	Description of change
V1.0	Initial version

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