Control board for automotive applications - STEVAL-TTM007A

Introduction

The STEVAL-TTM007A control board features the advanced Stellar E automotive-grade microcontroller SR5 E1 E7 (Stellar E 32-bit Arm® Cortex®-M7 automotive MCU 2x cores) with functional safety performance (ASIL-D capability). The dedicated peripheral designed for motor control renders it possible to develop and implement firmware architectures driving up to two independent motors. The latest motor control connector facilitates compatibility with the STEVAL-APD03ACB and STEVAL-APD04ACB driving boards from the dedicated electric traction kit capable of driving all the ACEPACK DRIVE product family based on the latest SiC MOSFET technology. The CAN, UART, and programmer connectors offer several interfaces with the MCU. The dedicated software tool StellarStudio for the Stellar E microcontroller family can be used to configure the STEVAL-TTM007A for each application with a user-friendly GUI.

The integrated SPSB100 AEC-Q100-qualified power management integrated circuit (PMIC) ensures appropriate power supply to the microcontroller and connectivity from the low voltage battery level.

Figure 1. STEVAL-TTM007A top view

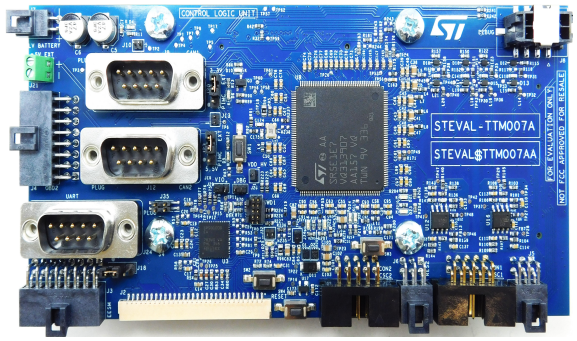
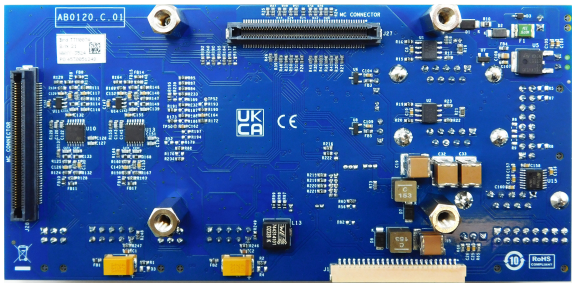


Figure 2. STEVAL-TTM007A bottom view



1 Evaluation kit features

1.1 Control board MCU main features and functional characteristics

1.1.1 SR5E1 features

- AEC-Q100 automotive qualification ongoing
- SR5 high-performance analog MCU offering:
  - Digital and analog high-frequency control requested by new wide-bandgap technologies (SiC and GaN)
  - Superior real-time and functional safety performance (ASIL-D capability)
  - Built-in fast and cost-optimized over-the-air (OTA) reprogramming capability (with built-in dual image storage)
  - High-speed security cryptographic services (HSM)

1.1.2 Cores

- 2x 32-bit Arm® Cortex®-M7 with double-precision FPU, L1 cache, and DSP instructions running at up to 306.7 MHz to reach 1284 DMIPS/2.14 DMIPS/MHz/Core (Dhrystone 2.1)
  - Split-lock configuration, allowing either 2 cores in parallel or 1 core in lockstep configuration
- 2 DMA engines in lockstep configuration

1.1.3 Memories

- Up to 2 MB on-chip flash memory with read while write support
  - 1920 KB code flash memory split in two banks allowing 960 KB OTA reprogramming support
  - 160 KB HSM dedicated code flash memory
- 96 KB data flash memory (64 KB + 32 KB dedicated to HSM)
- 488 KB on-chip general-purpose SRAM:
  - 2× 32 KB instruction TCM + 2× 64 KB data TCM
  - 256 KB system RAM
  - 40 KB HSM dedicated system RAM

1.1.4 Security: hardware security module (HSM)

- On-chip high-performance security module with EVITA medium support with dedicated RAM and flash memory
- Based on Cortex®-M0+ cores running up to 153.35 MHz (half of the system frequency)
- Hardware accelerator for symmetric cryptography

1.1.5 Safety: comprehensive new generation ASIL-D safety concept

- Comprehensive new generation ASIL-D safety concept
- State-of-the-art safety measures at all levels of the architecture for most efficient implementation of ISO26262 ASIL-D functionalities
- FCCU for collection and reaction to failure notifications with enhanced configurability
- Memory error management unit (MEMU) for collection and reporting of error events in memories
- Cyclic redundancy check (CRC) unit

1.1.6 Enhanced peripherals for fast control loop capability

- 12 timers:
  - 2x HRTIM (Hi-Resolution and complex waveform builder): 12x 16-bit counters, 104 ps resolution, 24 PWM in total
  - 2x 16-bit 6-channel advanced control timers, with up to 12x PWM, in total
  - 2x 32-bit general purpose timers, with up to 8x IC/OC/PWM or pulse counter and quadrature encoder input in total
  - 4x 16-bit general purpose timers, with up to 11x PWM, 2 of which paired, in total
  - 2x 16-bit basic timers
- Enhanced analog-to-digital converter system with:
  - 5 separate 12-bit SAR analog converters, 8 channels each. Sampling rate up to 2.5 MSPS in single mode, 5 MSPS in dual mode
  - 2 separate 16-bit sigma-delta analog converters
- 12-bit digital-to-analog converters (DAC)
  - 2 buffered external channels 1 MSPS
  - 8 unbuffered internal channels 15 MSPS
- 8 rail-to-rail analog comparators, 50 ns propagation delay
- Hardware accelerator
  - 1x CORDIC for trigonometric functions acceleration

1.1.7 Communication interfaces

- 4 modular controller area network (MCAN) modules, all supporting flexible data rate (ISO CAN-FD)
- 3 UART modules with LIN functionality
- 4 serial peripheral interface (SPI) modules, 2 multiplexed with I²S interfaces
- 2 I²C modules

1.1.8 Advanced debug and trace for high performance automotive application Development

- Built around Arm® CoreSight™-600
- Debug interface: Arm® CoreSight™ JTAG (IEEE 1149.1) or SWD
- 4 KB embedded trace FIFO for both on- and off-chip tracing
- Trace port for off-chip tracing: parallel trace port configurable from one to eight data lines

1.1.9 Others

- Power efficiency management, through separate power modes for any selected cores, peripherals, or memories
- Boot assist flash (BAF) supports factory programming using a serial loader through CAN or UART
- Junction temperature range -40 °C to 150 °C
- Integrated power supply scheme:
- Integrated internal SMPS regulator
- 3.3 V supply & GPIOs
- 12 timers:
  - 2× HRTIM (high-resolution and complex waveform builder): 12× 16-bit counters, up to 102 ps resolution, 24 PWM in total
  - 2× 16-bit 6-channel advanced control timers, with up to 12× PWM, in total
  - 2× 32-bit general purpose timers, with up to 8× IC/OC/PWM or pulse counter and quadrature encoder input in total
  - 4× 16-bit general purpose timers, with up to 11× PWM, 2 of which paired, in total
  - 2× 16-bit basic timers

- Enhanced analog-to-digital converter system with:
  - 5 separate 12-bit SAR analog converters, 8 channels each. Sampling rate up to 2.5 MSPS in single mode, 5 MSPS in dual mode
  - 2 separate 16-bit sigma-delta analog converters
- 12-bit digital-to-analog converters (DAC)
  - 2 buffered external channels 1 MSPS
  - 8 unbuffered internal channels 15 MSPS
- 8 rail-to-rail analog comparators, 50 ns propagation delay
- Hardware accelerator
  - 1× CORDIC for trigonometric functions acceleration

1.2 Target applications

The STEVAL-TTM007A is specifically designed for applications involving motor drives for:

- e-trucks
- e-cars

2 Safety and operating instructions

2.1 General terms

All operations involving transportation, installation, and use, as well as maintenance, has to be carried out by skilled technical personnel (national accident prevention rules must be observed). For the purpose of these basic safety instructions, "skilled technical personnel" are considered as suitably qualified people who are familiar with the installation, use, and maintenance of power electronic systems.

2.2 Intended use of evaluation kit

This evaluation kit is designed for demonstration purposes only and shall not be used for any commercial purpose. The technical data, as well as information concerning power supply conditions, must be taken from the relevant documentation and strictly observed.

2.3 Evaluation kit setup

The evaluation kit must be set up in accordance with the specifications and the targeted application.

The board contains electrostatically sensitive components that are prone to damage through improper use. Electrical components must not be mechanically damaged or destroyed.

Avoid any contact with other electronic components.

During the motor driving, converters must be protected against excessive strain. Do not bend or alter the isolating distances of any components during transportation or handling.

2.4 Electronic connections

Applicable national accident prevention rules must be followed when working on the main power supply with a motor drive. The electrical installation must be completed in accordance with the appropriate requirements. A system architecture that supplies power to the evaluation board must be equipped with additional control and protective devices in accordance with the applicable safety requirements (for example, compliance with technical equipment and accident prevention rules).

3 Development environment

3.1 System requirements

Windows® OS (7, 8, or 10), Linux® 64-bit, or macOS®

3.2 Development toolchains

The Stellar Studio software environment for SR5 family microcontrollers helps develop applications on SR5E microcontrollers with useful interfaces to configure communication peripherals, clock distribution, and pin mapping.

Stellar Studio is online and can be downloaded at:

https://www.st.com/en/development-tools/stellarstudio.html

3.3 Demonstration software

A demonstration application is available that initializes the microcontroller, enables the clock, configures the pins, controls an LED, and generates a PWM signal.

This demo was created using Stellar-E software development kit (SR5E1 SDK). The SR5E1 SDK is designed to develop applications for Stellar-E microcontrollers. Stellar-E SDK includes a build system with the support for different compilers, a free toolchain (GNU ARM), a set of modules for core initialization and peripheral drivers, and a set of examples to show how to configure and use the device and related peripherals.

This demo can be imported using Stellar Studio import wizard:

1. Select [**File**]>[**New**]>[**Other…**]
2. Select [**Stellar/StellarStudio Import**] wizard
3. Select the SR5E1-STEVAL-TTM007A control board and click [**Next**]
4. Choose sample application: `SR5E1_STEVAL_TTM007A_TEST_PWM_BLINK_LED`

4 Conventions

The following table provides the conventions used for the ON and OFF settings in this document.

Table 1. ON/OFF convention

Convention	Definition
Jumper Jx ON	Jumper fitted
Jumper Jx OFF	Jumper not fitted
Jumper Jx [1-2]	Jumper fitted between pin 1 and pin 2
Resistor Rx ON	Resistor mounted
Resistor Rx OFF	Resistor not mounted

5 Hardware Layout and Configuration

The STEVAL-TTM007A evaluation board is designed around the Stellar-E microcontroller SR5E1E7 in a 176-pin LQFP package.

The following figures and tables provide the following details:

- How the connectivity and the interfacing elements between the board's logic devices (MCU and PMIC) and the external tools useful for motor control application are arranged.
- The position and functioning of the user push button mounted on the board.
- The position and indication related to the turning on of the green and red LEDs present on the board.

Figure 3. STEVAL-TTM007A top view: external connectors

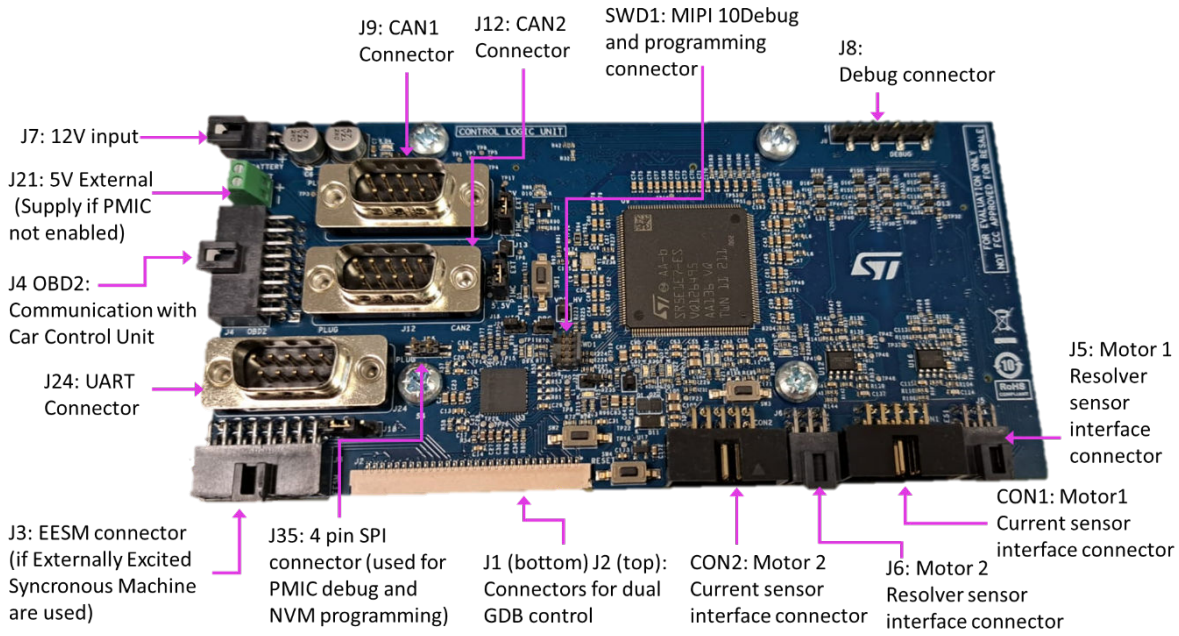


Figure 4. **STEVAL-TTM007A bottom view: external connectors.**

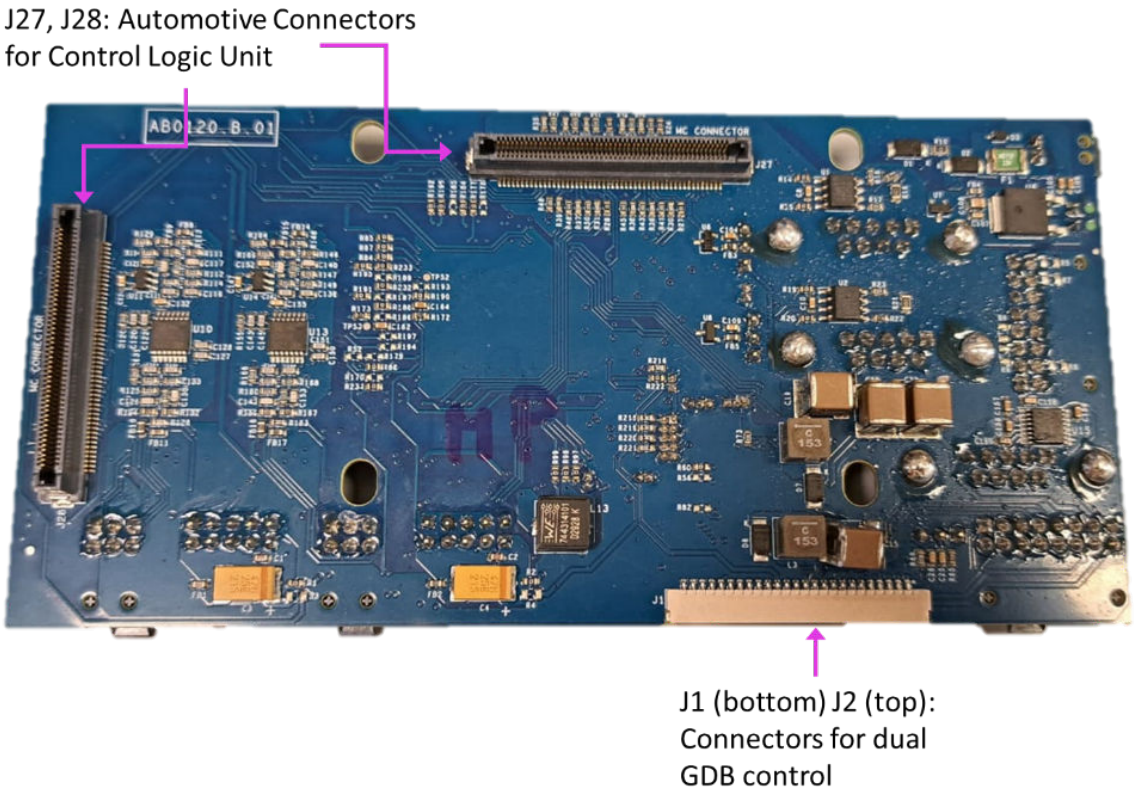


Table 2. **STEVAL-TTM07A connector descriptions**

Connector identifier	Connector type	Description	Mating connectors
J1	FI-S25P-HFE	Connectors for dual GDB control: Power supply connection	FI-S25S
J2	FI-S30P-HFE	Connectors for dual GDB control: Logic signal connections	FI-S30S
J3	MOLEX 1053141116 (nano-fit 2x8; 2.5mm pitch)	EESM connector:connecting control board to auxiliary DC-DC for rotor excitation (EESM motor)	MOLEX 1053081216
J4	MOLEX 1053141116 (nano-fit 2x8; 2.5mm pitch)	OBD2 connector:connecting the MCU to the car Central Logic Unit (CLU)	MOLEX 1053081216
J5	MOLEX 1053141206	RES1: connection of excitation signal, sine and cosine signals from resolver of Motor 1	MOLEX 1053081206
J6	MOLEX 1053141206	RES2: connection of excitation signal, sine and cosine signals from resolver of Motor 2	MOLEX 1053081206
J7	MOLEX 1053131102	12 V main power supply	MOLEX 1053071202
J8	MOLEX 1054051208	Debug connector: connection to DAC channels and emergency input and output signals	MOLEX 1053081208
J9	CONN D-SUB PLUG 9POS	CAN1: CAN1 interface of MCU	CONN D-SUB RCPT 9POS
J12	CONN D-SUB PLUG 9POS	CAN2: CAN2 interface of MCU	CONN D-SUB RCPT 9POS
J21	Conn PC terminal block 2 POS 2.54mm solder ST thru-hole 6A cardboard	5V_EXT: used to supply MCU if SPSB100 is not used	Whichever wire up to 20 AWG

Connector identifier	Connector type	Description	Mating connectors
J24	CONN D-SUB PLUG 9POS	UART: UART interface of MCU	CONN D-SUB RCPT 9POS
J27	MA01R100VABBR600	MC connector: used for connecting the control board to the main driver board	MA01F100VABB
J28	MA01R100VABBR600	MC connector: used for connecting the control board to the main driver board	MA01F100VABB
J35	SamtecFTR-102-02-S-D	PMIC SPI connector used in case of NVM programming of SPSB100	SamtecRSM-102-02-L-D
CON1	SBH11-PBPC-D05-RA-BK	Current sense 1: connection of 3-phase current signals and power supply for external Motor 1 sensors	SFH210-PPEC-D05-ID-BK
CON2	SBH11-PBPC-D05-RA-BK	Current sense 2: connection of 3-phase current signals and power supply for external Motor 2 sensors	SFH210-PPEC-D05-ID-BK
SWD1	SamtecFTSH-105-01-L-D-K	Programming connector for MCU. Connect here external debugger	Samtec FFSD-05-D-06.00-01-N

Figure 5. STEVAL-TTM007A top view: push button positions

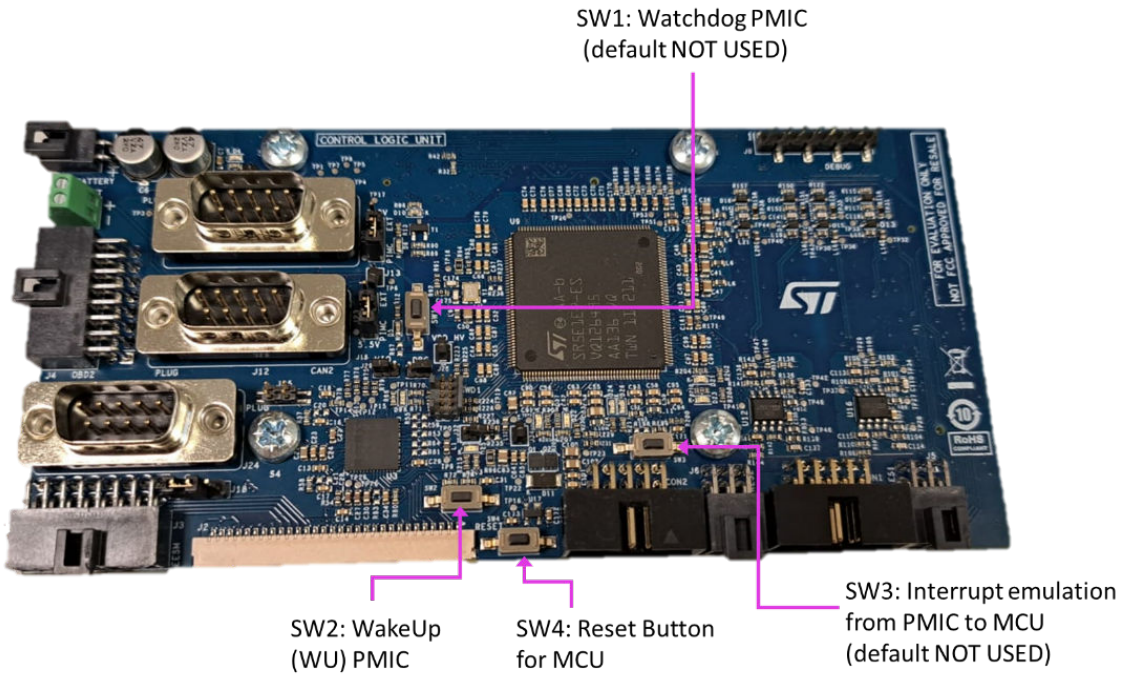


Table 3. Push button descriptions

Button identifier	Switch type	Description
SW1	Normally OFF	It can be used to enter the NVM programming mode of the PMIC by pulling up the SWDBG pin of the SPSB100 (by default is disconnected since R67 not mounted)
SW2	Normally OFF	It can be used to send a wake-up command to the PMIC if it enters deep-sleep
SW3	Normally OFF	It can be used to pull down the MCU input assigned to the handle the IRQ (interrupt request) from the PMIC (by default is disconnected since R199 not mounted)
SW4	Normally OFF	It can be used as a standard reset button for the MCU by pulling-down the related pin

Figure 6. **STEVAL-TTM07A LED positions**

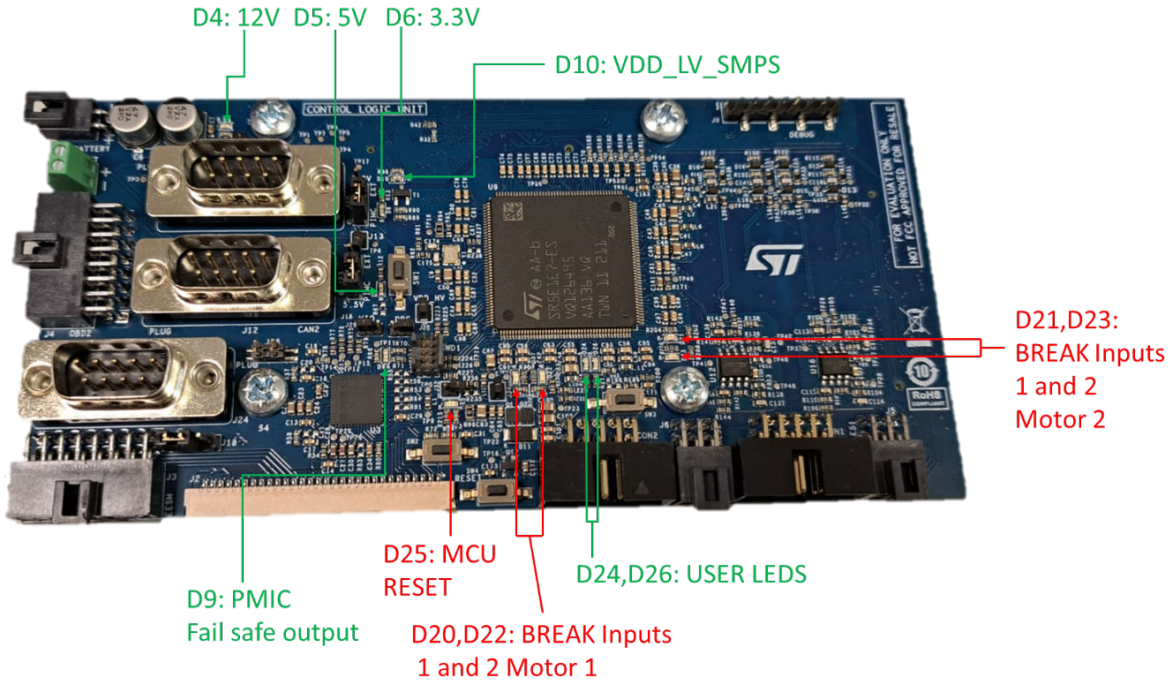


Table 4. **LED descriptions**

LED identifier	Color	Description
D4, D5, D6	Green	If turned ON, they indicate the presence of respectively 12 V, 5V, 3.3 V.
D9	Green	It is connected to the NFSO1 pin of the PMIC. NFSO1 is asserted low when a fault event is detected. Consequently, D9 turns ON.
D10	Green	If turned ON, it indicates the presence of 1.2 V generated by an external push pull driven by the MCU.
D24, D26	Green	User LEDs can blink or be turned ON according to the firmware uploaded on the MCU.
D25	Red	It is connected to the reset circuitry. It turns on if the reset command is sent to MCU (for example, pressing SW4).
D20, D21, D22, D23	Red	These LEDs are connected to the emergency BREAK input (BREAKIN) of the MCU. (for example, turned ON after a fault diagnosed by the driver).

6 Quick Start

The STEVAL-TTM007A board allows evaluation of the capabilities of the Stellar-E microcontroller for full motor control firmware development and the SPSB100 for power management, including the ability to meet functional safety requirements as defined by the automotive safety integrity level (ASIL).

6.1 Jumper setup

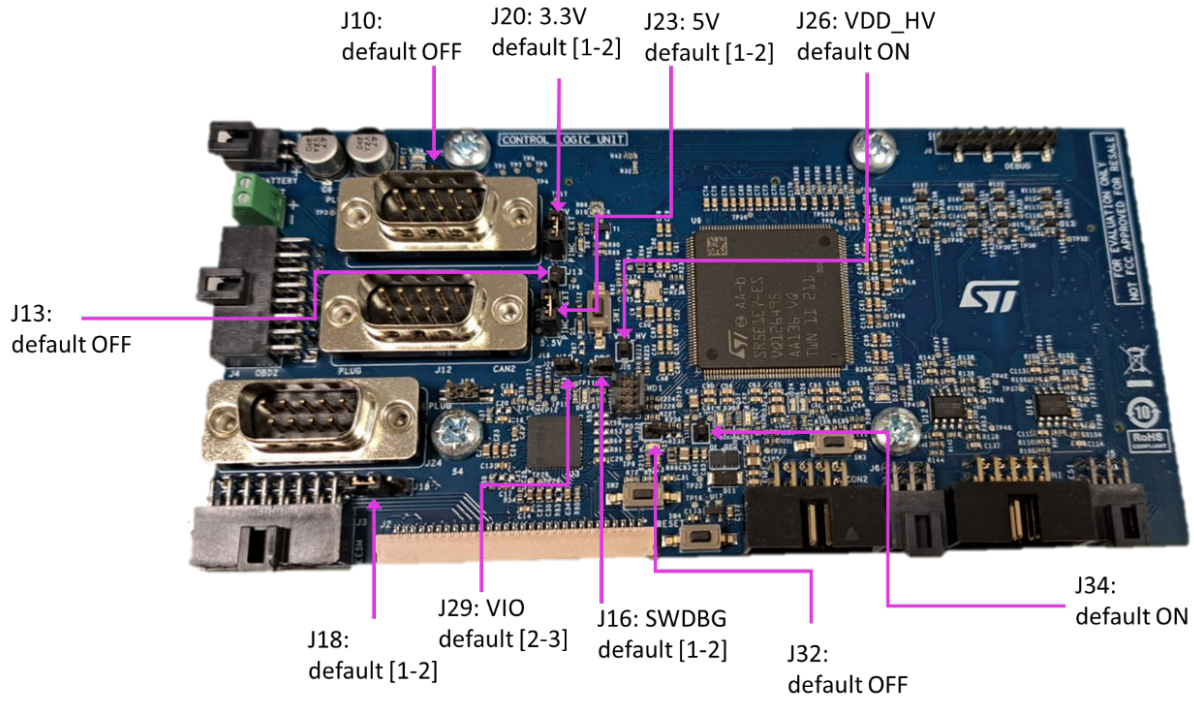
Connect the jumper according to the following configuration:

Note: The pin numbered as 1 is indicated with a white dot on the screen printing.

Table 5. Default jumper connections

Jumper	Connection	Description	Screen printing
J10	OFF	Enable CAN1 terminator resistor	-
J13	OFF	Enable CAN2 terminator resistor	-
J32	OFF	Reset enable from PMIC to MCU	-
J26	ON	JTAG compliance pin pull-up enable	VDD_HV
J34	ON	3.3 V jumper for MCU current measurement	-
J20	If SPSB100 enabled:[1-2]	Selection of 3.3 V supply (external/PMIC)PMIC->default	3.3 V
J23	If SPSB100 enabled:[1-2]	Selection of 5 V supply (external/PMIC)PMIC->default	5 V
J18	[1-2]	Ignition command (default high level)	-
J16	[1-2]	SWDBG pin (PMIC) connection selection (VDD/GND)GND->default	SWDBG
J29	If SPSB100 enabled: [2-3]	PMIC Input/Output power supply selection (external/PMIC)PMIC->default	VIO

Figure 7. STEVAL-TTM007A jumper positions



6.2 Power supply

The STEVAL-TTM07A requires a 12V input power source to enable all its functions. The SPSB100 buck regulators ensure the appropriate 3.3 V and 5 V voltages to all the board ICs.

The 12 V must be supplied through the header connector J7.

To bypass the SPSB100 and its functions, you can supply the 5 V externally through the connector J21. From this external supply the 3.3 V is generated through a separate LDO from the SPSB100.

In this case, jumpers J20 and J23 must be fitted in the [2-3] position.

Note: With every setup the 12 V must be externally provided anyway.

Figure 8. STEVAL-TTM007A power tree

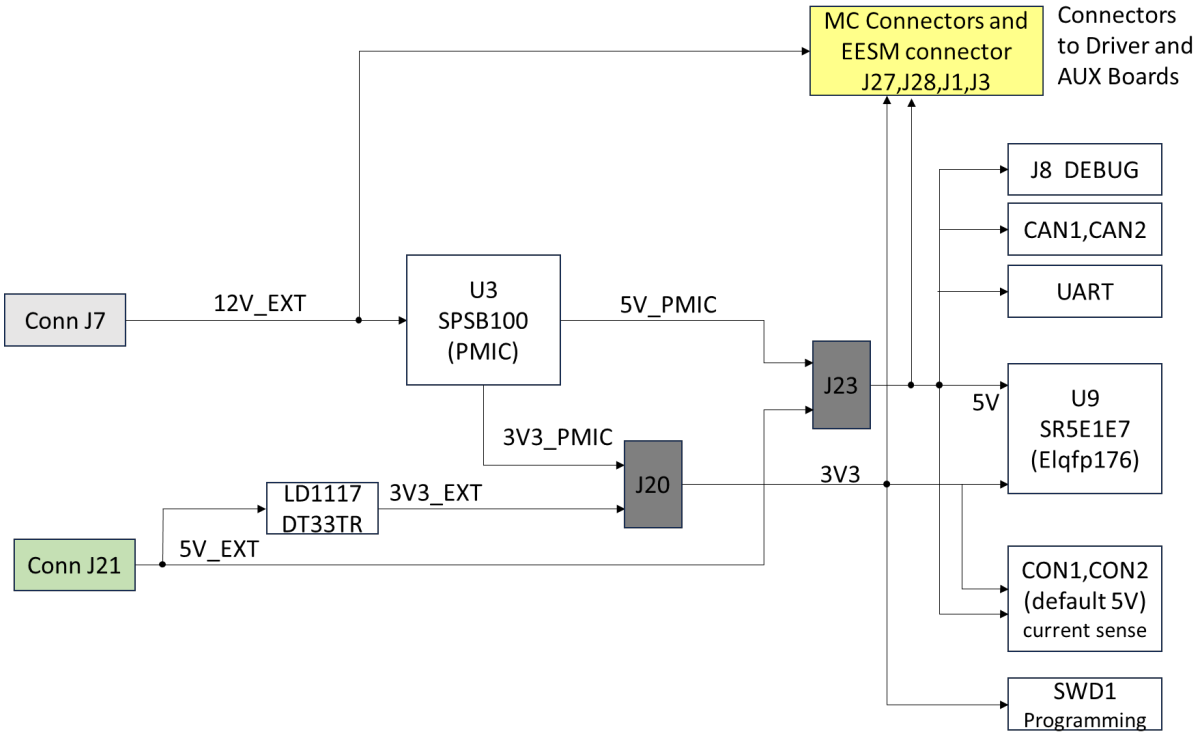


Table 6. Configurations available for power supply

Jumper	12 V	5 V	3.3 V
J23/J20[1-2]	Provided through J7	Generated internally (through PMIC)	Generated internally (through PMIC)
J23/J20[2-3]	Provided through J7	Provided through J21	Generated internally (through LD1117)

Note: If the SPSB100 is not programmed (consequently J23/J29 are in [2-3] position), and you want to establish communication with the SPSB100 through SPI by using the connector J35, you must change the selection of the jumper J29 and use [1-2].

6.3 Current Sensing Section

The STEVAL-TTM007A provides two independent connectors that can be plugged with the output of current sensors like Hall effect sensors. The availability of the two current sensor connectors is related to the possibility of driving two independent motors simultaneously. Connector CON1 can be used to sense the three phase currents of Motor 1 and CON2 for the currents of Motor 2. Each connector effectively allows the current sensor to choose between 5 V and 3.3 V by suitably soldering the 0-ohm resistors.

Table 7. Configurations available for current sensor supplies

Resistors	5 V	3.3 V
R1 ON and R2 ON R3 OFF and R4 OFF	Selected	x
R1 OFF and R2 OFF R3 ON and R4 ON	x	Selected

Figure 9. Current sensing connector schematic

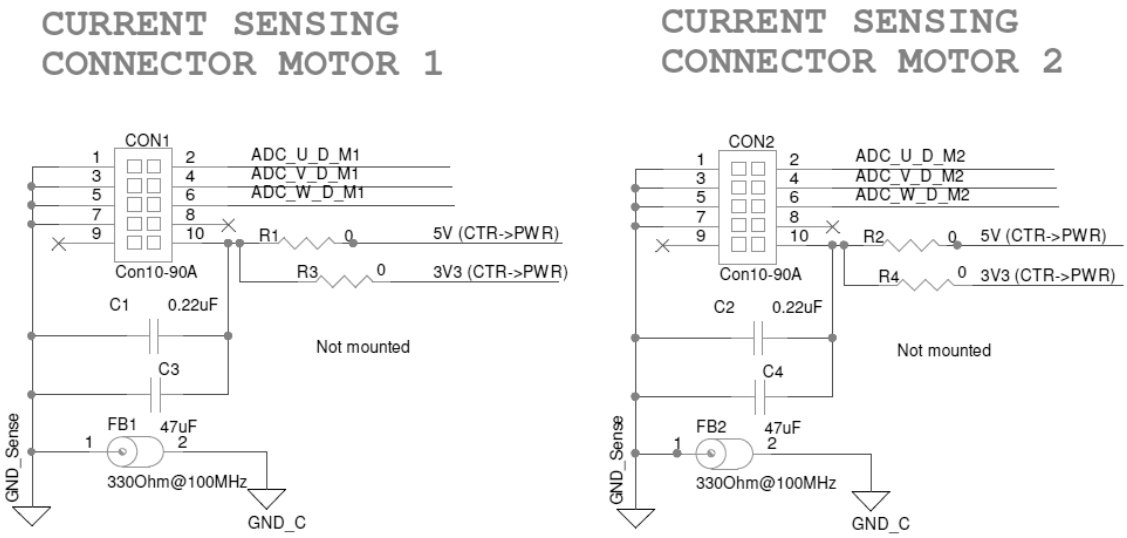


Figure 10. Current sensing RC filtering

The sensed signals from the three phases are individually filtered and routed to the ADC pins of the StellarE microcontroller. Six identical RC filters are interposed between the connectors and the pins of the MCU (R=510 W;C=10 nF).

The table below shows the default current signal pins on the Stellar-E microcontroller.

Table 8. CON1 and CON2 pinout

PIN n°	Connector	Connection
1,3,5,7	CON1	GND
	CON2	GND
8, 9	CON1	NOT CONNECTED
	CON2	NOT CONNECTED
2	CON1	Current phase U-Motor1signal read from sensor
	CON2	Current PhaseU-Motor2signal read from sensor
4	CON1	Current PhaseV-Motor1signal read from sensor

PIN n°	Connector	Connection
4	CON2	Current PhaseV-Motor2signal read from sensor
6	CON1	Current phase W-Motor1signal read from sensor
	CON2	Current phase W-Motor2signal read from sensor
10	CON1	Power supply (5 V or 3.3 V)
	CON2	Power supply (5 V or 3.3 V)

Table 9. ADC channels: SR5E1 pin connection for current reading

Motor	Current	PIN	Peripheral
Motor 1	Phase U	PB2	SAR1_IN1
	Phase V	PB7	SAR2_IN1
	Phase W	PC1	SAR_CAL1
Motor 2	Phase U	PB12	SAR3_IN1
	Phase V	PC3	SAR4_IN1
	Phase W	PC	SAR_CAL2

6.4 Resolver circuit section for position sensing

The STEVAL-TTM007A is predisposed to work with resolver position sensors. It has two independent connectors that can work with two resolvers, each related to a different motor, in compliance with the capability of the control board to support firmware for driving two motors.

The connectors offer the possibility to feed a differential signal to the excitation winding of the resolver, and to read two differential signals coming from the position sensor, which can be demodulated to obtain the quadrature signals denoted cosine and sine signals. The reconstruction of the angle and of the speed is then addressed to the MCU, which computes them via firmware thanks to PLL algorithm.

The excitation signals are generated by the BDAC peripheral of the SR5E1 MCU and amplified by the circuit in Figure 12, also obtaining a differential signal starting from a single ended one.

The signals that come from the resolver, on the other hand, need to be scaled by the circuit in Figure 13, passing from a differential signal to a single-ended signal. The resulting conditioned signal in the range 0-3.3V can be read by the ADC channel of the MCU.

Figure 11. Resolver connectors' schematic.

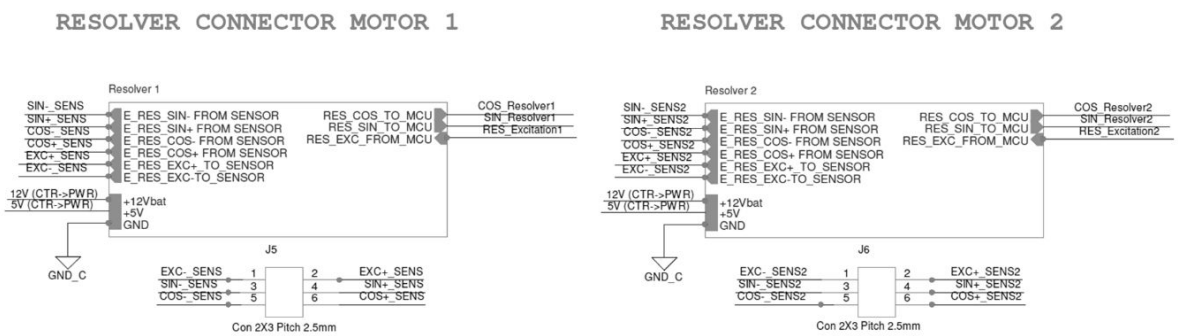


Figure 12. **Resolver conditioning circuit: excitation amplifying stage.**

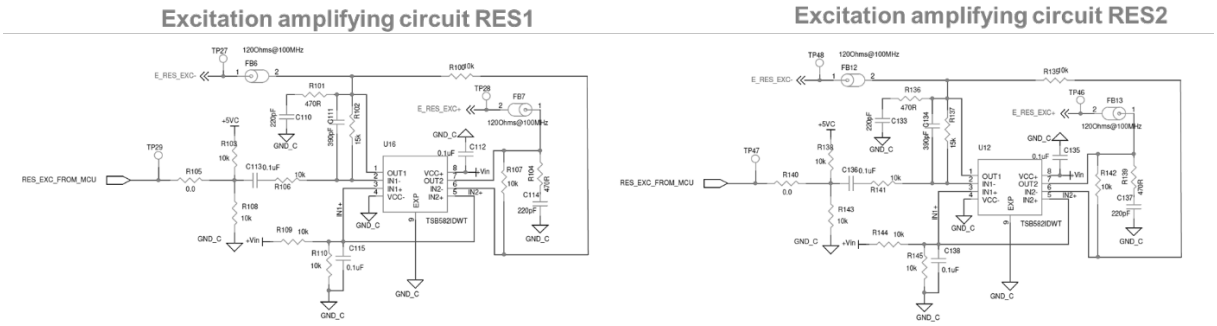
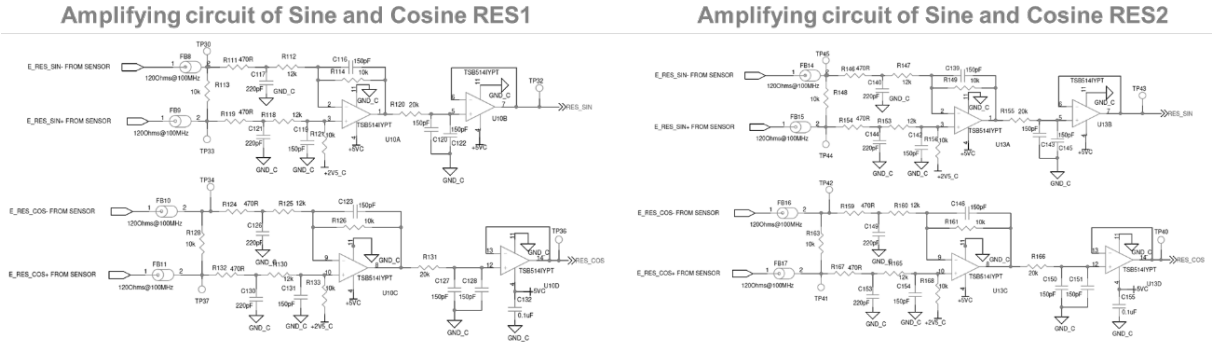


Figure 13. **Resolver conditioning circuit: cosine and sine signal amplifying stages**



$$A_V = \frac{V_{out}}{V_{in}} = \frac{V_{out}}{V_{in}}$$

Table 10. **RES1 and RES2 pinout**

PIN n°	Connectors	Connection
1	RES1/RES2	EXC-_SENS: Negative terminal of EXCITATION signal
2	RES1/RES2	EXC+_SENS: Positive terminal of EXCITATION signal
3	RES1/RES2	SIN-_SENS: Negative terminal of SINE signal
4	RES1/RES2	SIN+_SENS Positive terminal of SINE signal
5	RES1/RES2	COS-_SENS: Negative terminal of COSINE signal
6	RES1/RES2	COS+_SENS Positive terminal of COSINE signal

Table 11. **ADC and DAC channels: SR5E1 pin connection for resolver sensing.**

Resolver	Function	PIN	Peripheral
RES1	COS	PB14	SAR3_IN3
	SIN	PB13	SAR3_IN2
	EXCITATION	PB1	B-DAC1_OUT

Resolver	Function	PIN	Peripheral
RES2	COS	PC6	SAR4_IN3
	SIN	PC4	SAR4_IN2
	EXCITATION (enabled if R178 ON)	PC5	B-DAC2_OUT

Note: The resolver of Motor 2 must be enabled. By default, the resistor R178 is not mounted. To enable the functioning of the second position sensor R178 must be mounted.

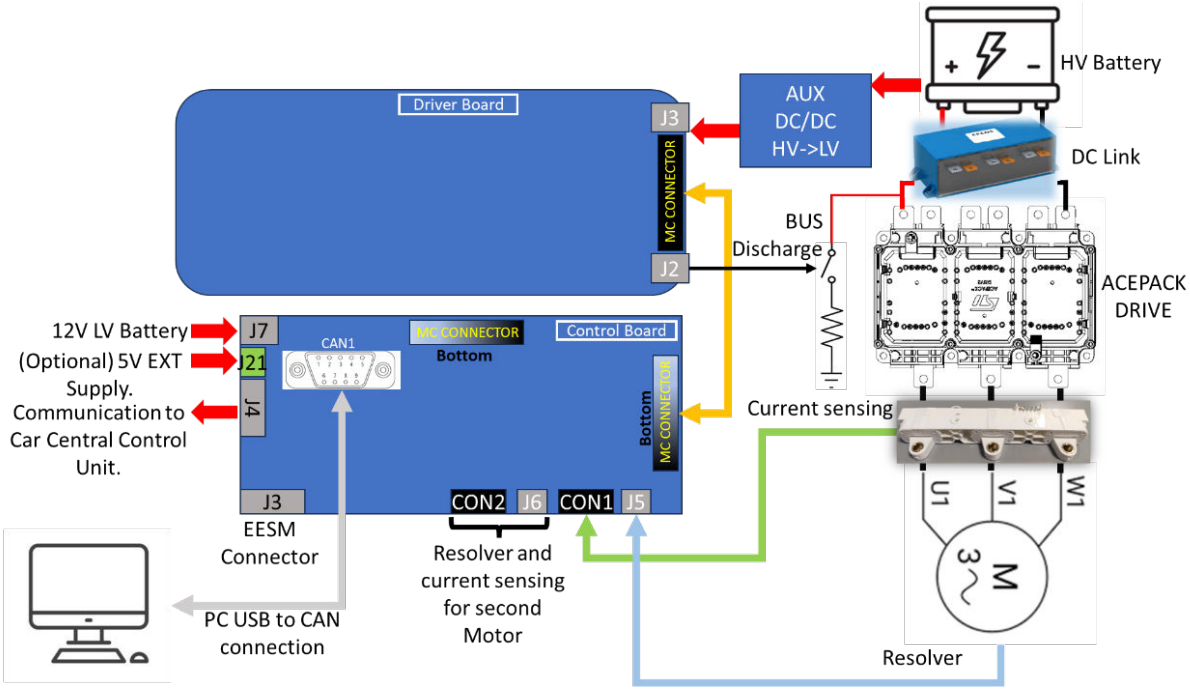
7 Board to board connections

The STEVAL-APD03ACB can work with the latest power modules like the ACEPACK DRIVE. For the connection between the APD03ACB and the ACEPACK it is possible to follow the press fitting procedure already mentioned. The other interconnections required for a complete system to be tested or used are depicted in the following image. The boards are schematized for legibility, but in the complete setup, they are stacked one on top of the other. The motor control (MC) connector must be plugged directly on the control board. There is no need to provide 12 V power supply to the driver board as long as the correct voltage level is delivered to the J7 connector of the control coard. The 5V EXT supply (J21) connector allows a dedicated supply for the microcontroller, if required.

The J3 connector of the driver board is used to provide a backup 12 V power supply that ensures a higher level of service continuity in case of LV battery failures. It can be connected to an auxiliary step-down isolated DC-DC that provides the same voltage level of the low voltage battery when the power source is the HV battery.

The J2 connector of the driver board can be connected to the backup power supply and to an external resistor that is used to safely discharge the DC link and avoid failures linked to the energy stored by these capacitors in emergency conditions.

Figure 14. Example of application case interconnections



8 Schematic diagrams

Figure 15. **STEVAL-TTM007A schematic diagram (1 of 10)**

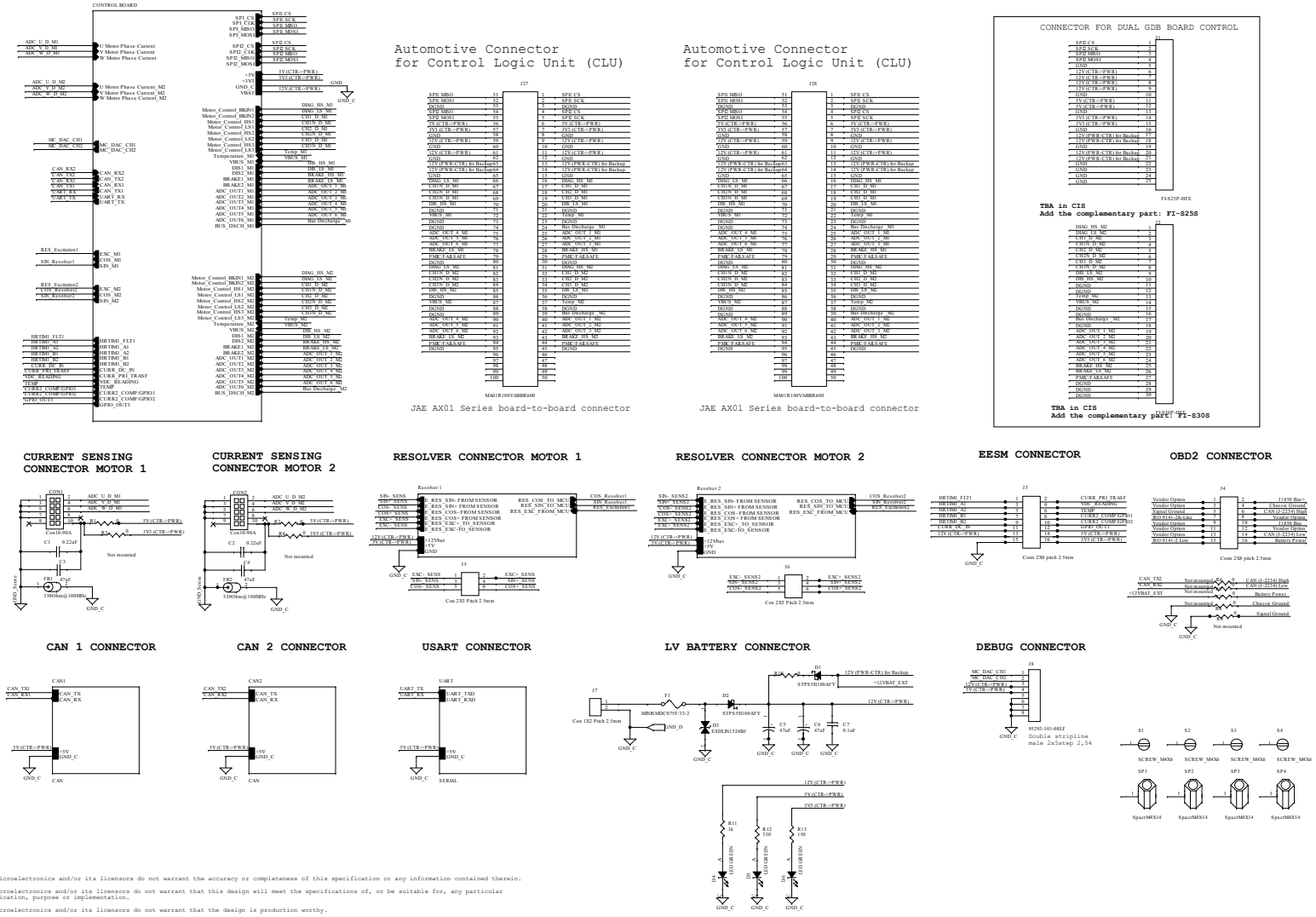


Figure 16. **STEVAL-TTM007A schematic diagram (2 of 10)**

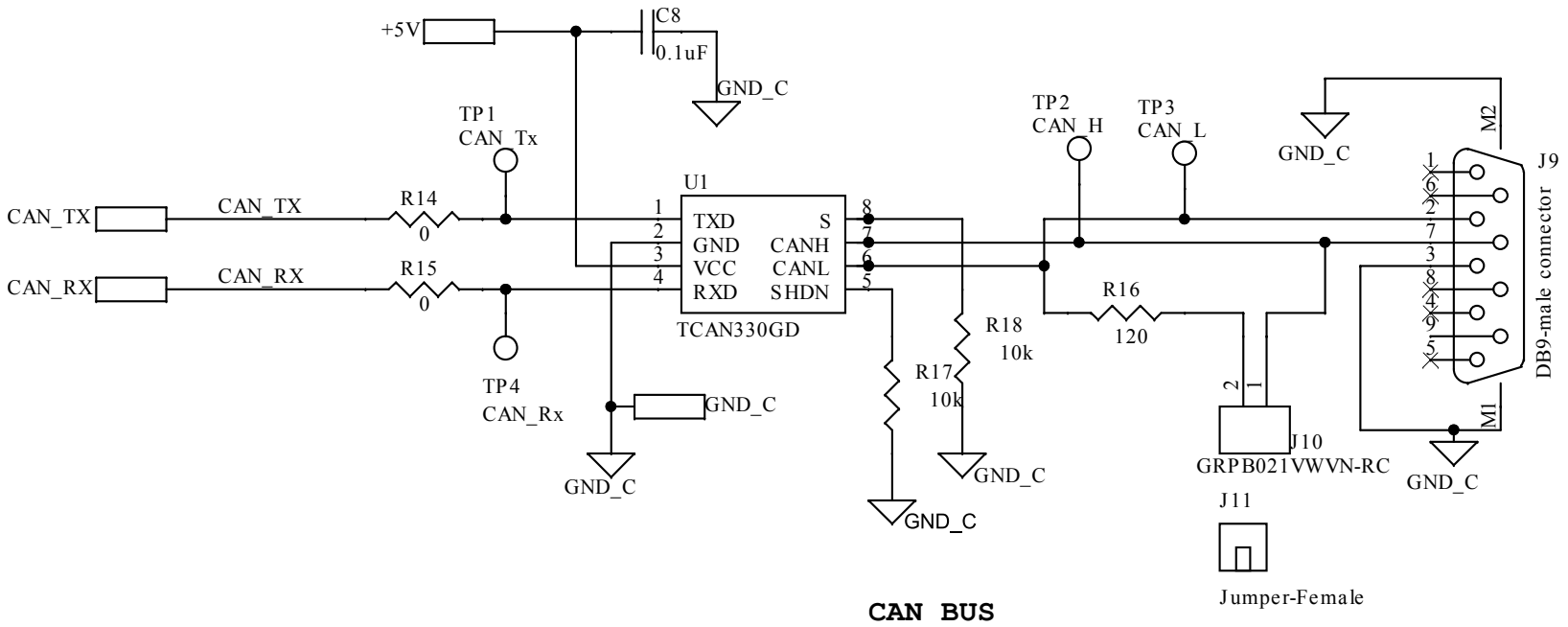


Figure 17. **STEVAL-TTM007A schematic diagram (3 of 10)**

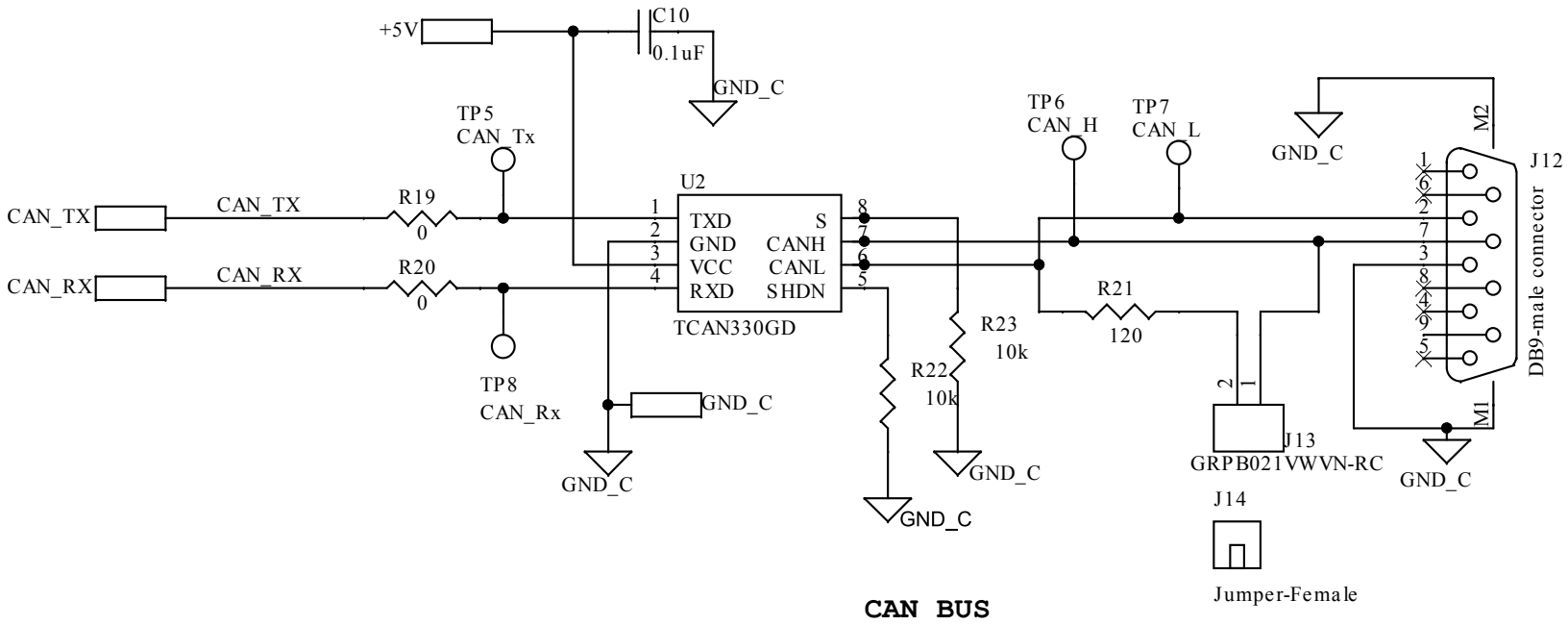


Figure 18. STEVAL-TTM007A schematic diagram (4 of 10)

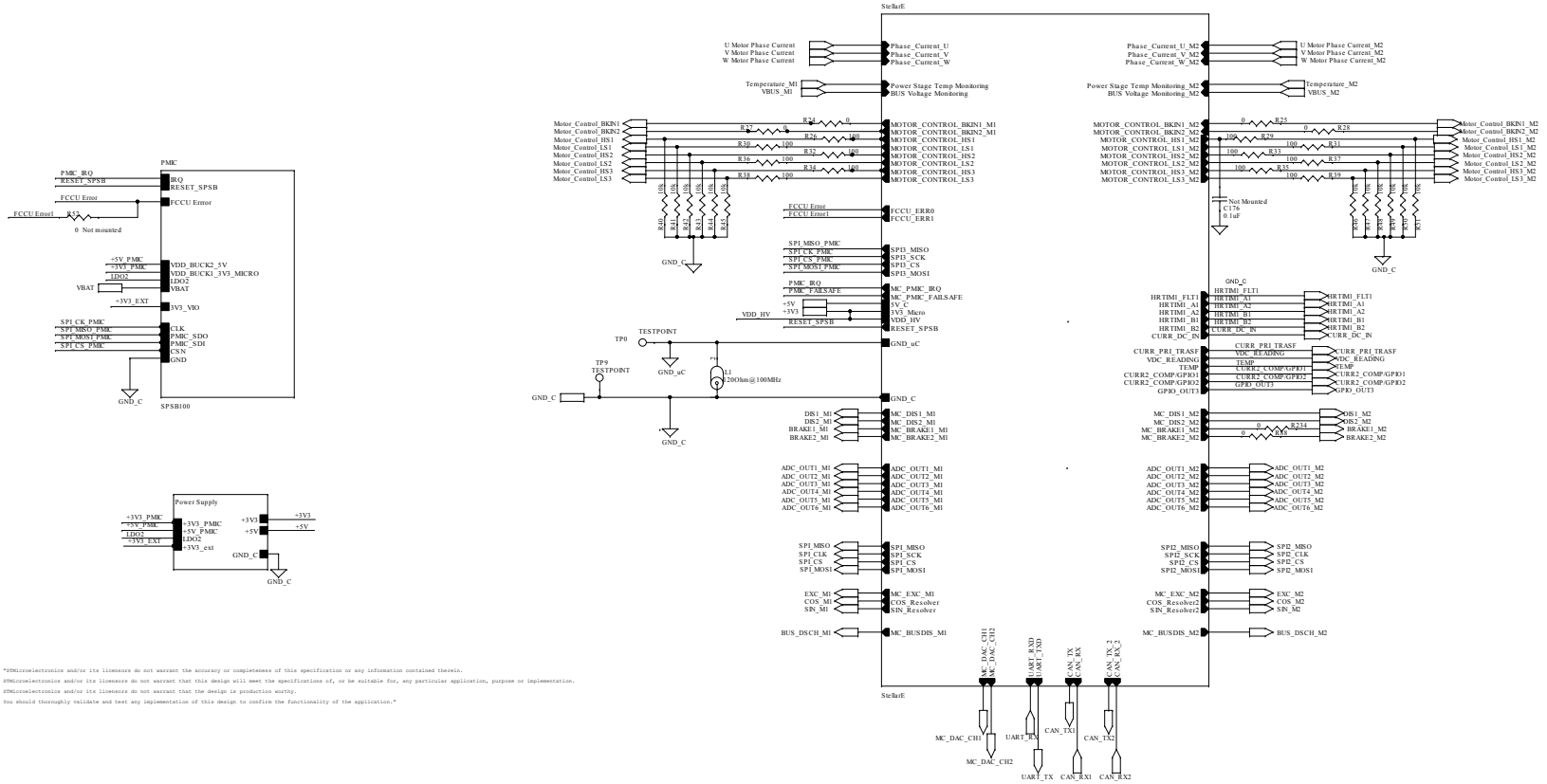


Figure 19. STEVAL-TTM007A schematic diagram (5 of 10)

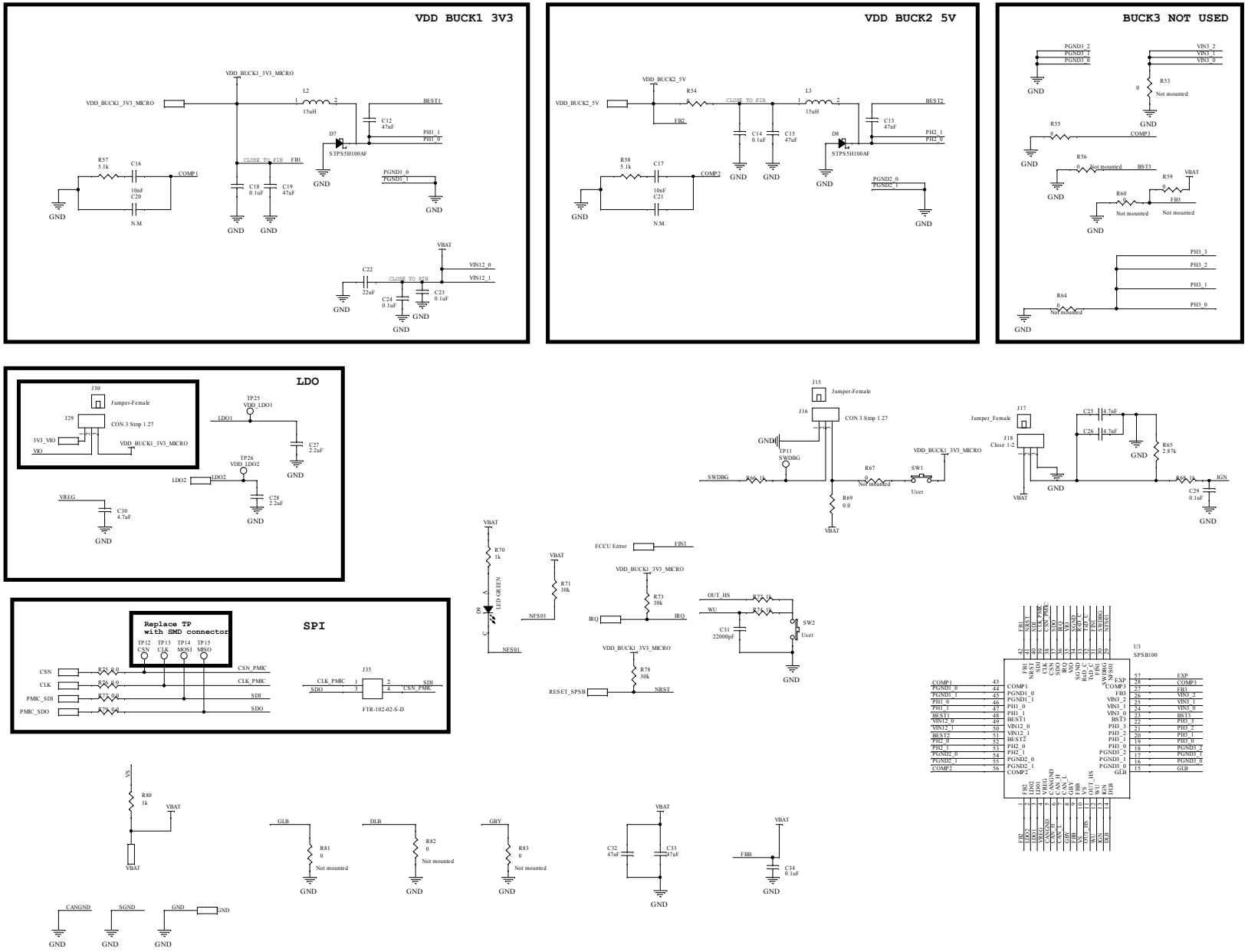


Figure 20. STEVAL-TTM007A schematic diagram (6 of 10)

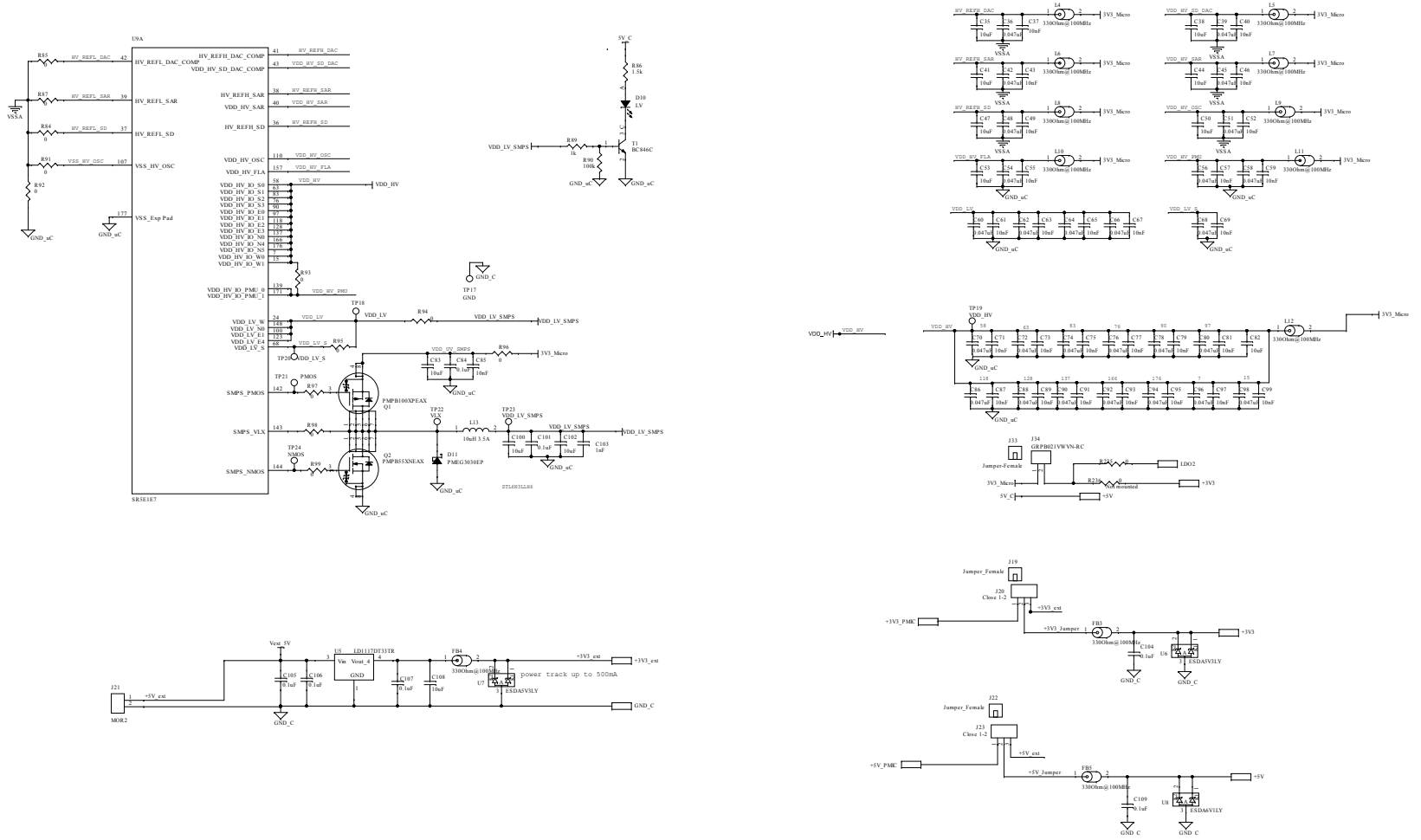


Figure 21. STEVAL-TTM007A schematic diagram (7 of 10)

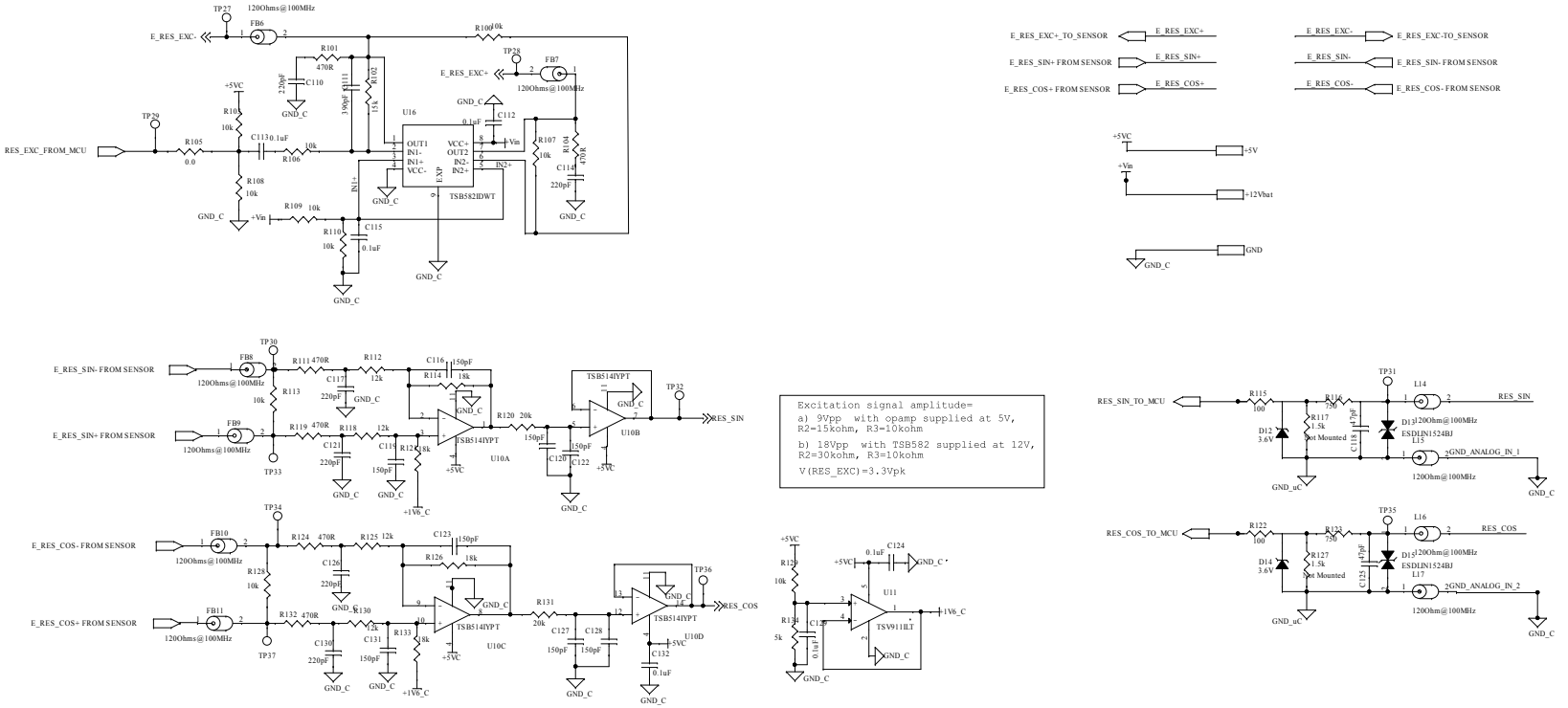


Figure 22. STEVAL-TTM007A schematic diagram (8 of 10)

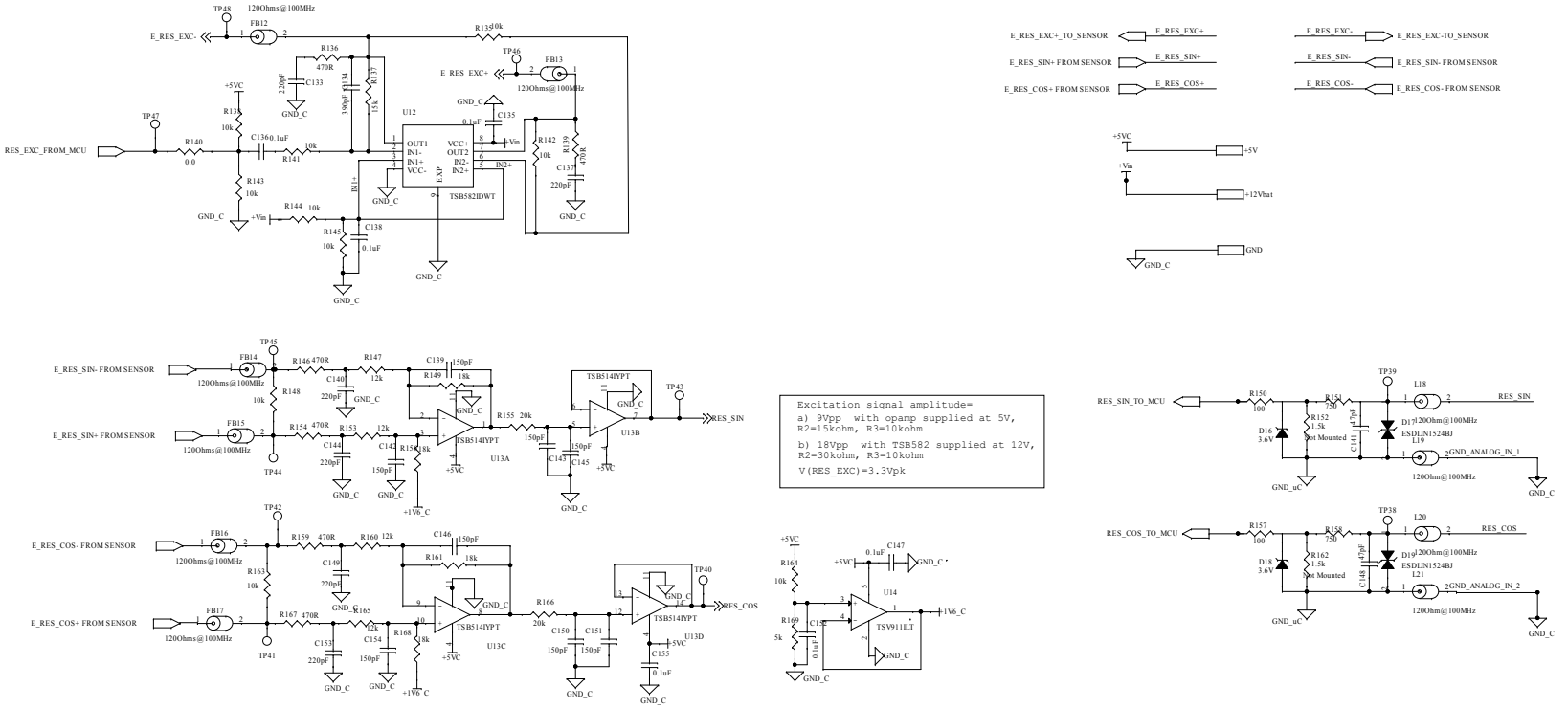
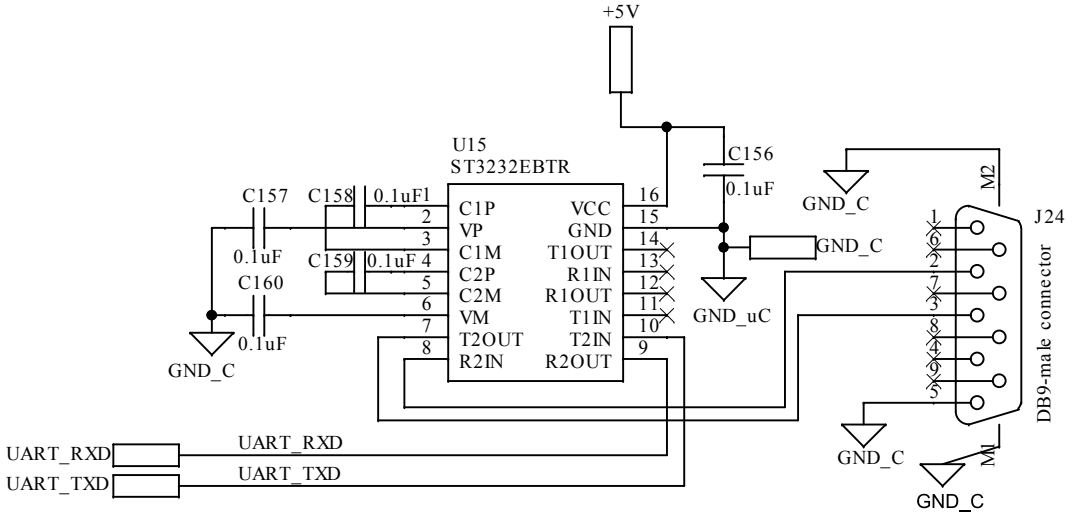
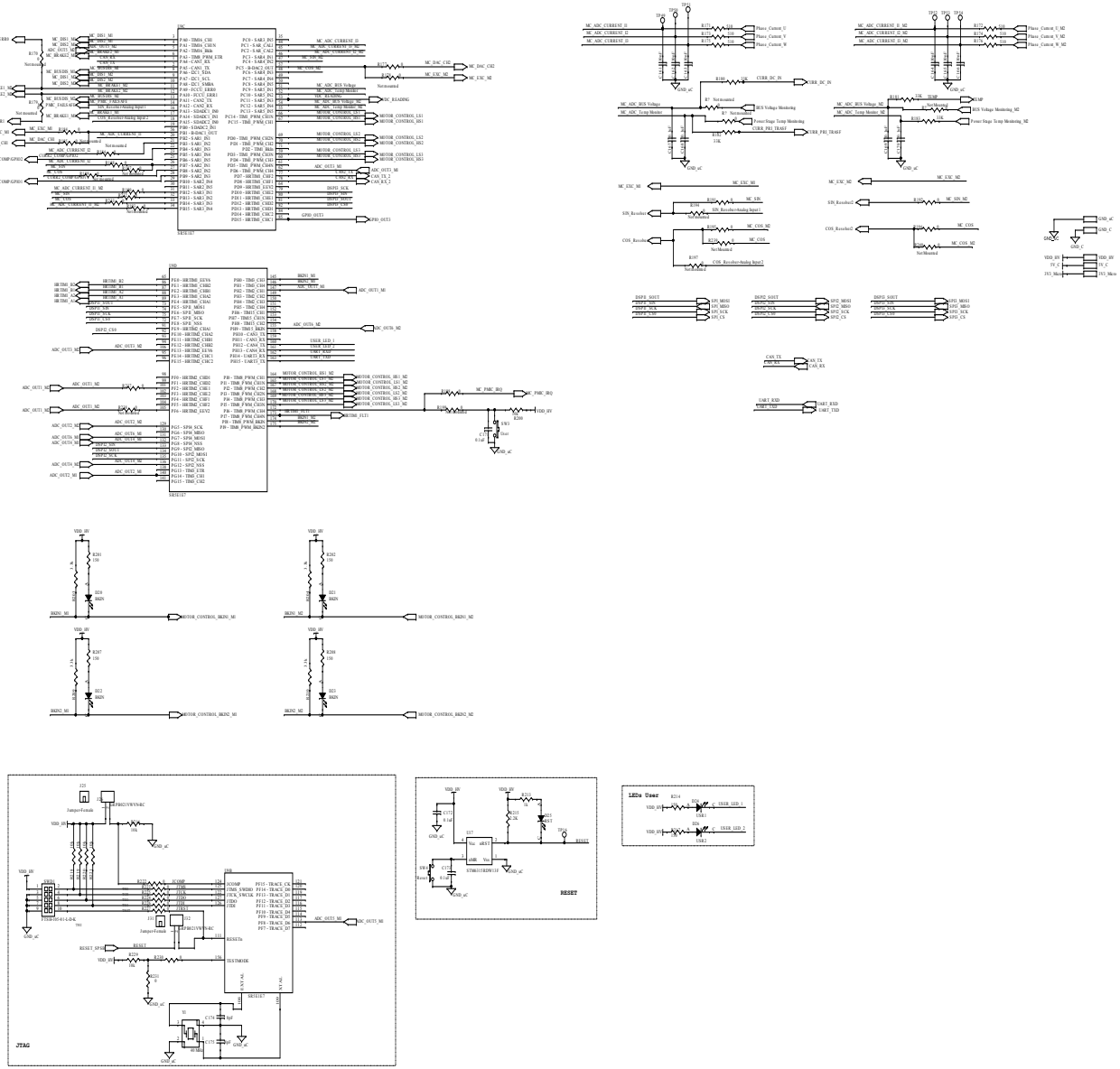


Figure 23. **STEVAL-TTM007A schematic diagram (9 of 10)**



UART - RS 232

Figure 24. STEVAL-TTM007A schematic diagram (10 of 10)



9 Bill of materials

Table 12. **STEVAL-TTM007A bill of materials**

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	2	C1, C2	0.22uF	CAP CER 0.22UF 50V X7R 0603	TDK Corporation	CGA3E3X7R1H224K080AB
2	2	C3, C4	47uF	CAP TANT 47UF 25V 10% 2917	KEMET	T491D476K025ATAUTO
3	2	C5, C6	47uF	CAP ALUM POLY HYB 47UF 35V SMD	Panasonic Electronic Components	EEH-ZA1V470P
4	1	C7	0.1uF	CAP CER 0.1UF 50V X7R 0603	KEMET	C0603C104K5RACTU
5	16	C8, C10, C104, C109, C156, C157, C158, C159, C160, C167, C168, C169, C170, C171, C172, C173	0.1uF	CAP, Ceramic, SMD, 0.1 uF, 10 %, 25 V, 0603	KEMET	C0603C104K3RAC
6	2	C12, C13	47nF	CAP CER 0.047UF 50V X7R 0603	Murata Electronics	GCM188R71H473KA55D
7	6	C14, C18, C23, C24, C29, C34	0.1uF	CAP CER 0.1UF 50V X7R 0603	KEMET	C0603C104J5RACTU
8	4	C15, C19, C32, C33	47uF	CAP CER 47UF 35V X7R SMD	Murata Electronics	KRM55WR7YA476MH01K

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
9	30	C16, C17, C37, C40, C43, C46, C49, C52, C55, C57, C59, C61, C63, C65, C67, C69, C71, C73, C75, C77, C79, C81, C85, C87, C89, C91, C93, C95, C97, C99	10nF	CAP CER 10000PF 10V X7R 0603	Wurth Electronics Inc.	885012206014
10	2	C20, C21	N.M.	CAPACITOR CERAMIC SMD 0603	/	/
11	1	C22	22uF	CAP CER 22UF 16V X5R 0603	Samsung Electro	CL10A226MO7JZNC
12	2	C25, C26	4.7nF	CAP CER 4700PF 25V X7R 0603	Wurth Electronics Inc.	885012206063
13	2	C27, C28	2.2uF	CAP CER 2.2UF 16V X7S 0603	TDK Corporation	CGA3E1X7S1C225M080AC
14	1	C30	4.7uF	CAP CER 4.7UF 10V X5R 0603	Wurth Electronics Inc.	885012106012
15	1	C31	22000pF	CAP CER 0.022UF 25V X7R 0603	Wurth Electronics Inc.	885012206067
16	12	C35, C38, C41, C44, C47, C50, C53, C82, C83, C100, C102, C108	10uF	CAP CER 10UF 16V X5R 0805	Wurth Electronics Inc.	885012107014

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
17	27	C36, C39, C42, C45, C48, C51, C54, C56, C58, C60, C62, C64, C66, C68, C70, C72, C74, C76, C78, C80, C86, C88, C90, C92, C94, C96, C98	0.047uF	CAP CER 0.047UF 100V X7R 0603	Wurth Electronics Inc.	885012206118
18	5	C84, C101, C105, C106, C107	0.1uF	CAP CER 0.1UF 25V X7R 0603	KEMET	C0603C104K3RACTU
19	1	C103	1nF	CAP CER 1000PF 25V X7R 0603	Samsung Electro	CL10B102KA8NNNC
20	12	C110, C114, C117, C121, C126, C130, C133, C137, C140, C144, C149, C153	220pF	CAP CER 220PF 50V X7R 0603	Samsung Electro	CL10B221KB8NNNC
21	2	C111, C134	390pF	CAP CER 390PF 50V C0G/NP0 0603	Murata Electronics	GRM1885C1H391JA01D
22	12	C112, C113, C115, C124, C129, C132, C135, C136, C138, C147, C152, C155	0.1uF	CAP CER 0.1UF 16V X7R 0603	Wurth Electronics Inc.	885012206046

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
23	16	C116, C119, C120, C122, C123, C127, C128, C131, C139, C142, C143, C145, C146, C150, C151, C154	150pF	CAP CER 150PF 100V C0G 0603	TDK Corporation	CGA3E2C0G2A151J080AD
24	4	C118, C125, C141, C148	47pF	CAP CER 47PF 50V C0G 0603	TDK Corporation	C1608C0G1H470J080AA
25	6	C161, C162, C163, C164, C165, C166	10nF	CAP CER 10000PF 100V X7R 0603	TDK Corporation	C1608X7R2A103M080AA
26	2	C174, C175	8pF	CAP CER 8PF 50V C0G/NPO 0603	Yageo	CC0603DRNPO9BN8R0
27	1	C176	0.1uF	CAP, Ceramic, SMD, 0.1 uF, 10 %, 25 V, 0603	Kemet	C0603C104K3RAC
28	2	CON1, CON2	Con10-90A	CONN HEADR 2.54MM 10POS GOLD R/A	Sullins Connector Solutions	SBH11-PBPC-D05-RA-BK
29	2	D1, D2	STPS5H100AFY, SOD128 Flat	DIODE SCHOTTKY 100V 5A SOD128	ST	STPS5H100AFY
30	5	D3, D13, D15, D17, D19	ESDLIN1524BJ, SOD323	TVS DIODE 15V/24V 35V/50V SOD323	ST	ESDLIN1524BJ
31	4	D4, D5, D6, D9	LED GREEN	LED GREEN DIFFUSED 0603 SMD	OSRAM Opto Semiconductors Inc.	LP L296-J2L2-25-Z
32	2	D7, D8	STPS5H100AF, SOD128 Flat	DIODE SCHOTTKY 100V 5A SOD128	ST	STPS5H100AF
33	1	D10	LV	LED GREEN DIFFUSED 0603 SMD	OSRAM Opto Semiconductors Inc.	LP L296-J2L2-25-Z
34	1	D11	PMEG3030EP	DIODE SCHOTTKY 30V 3A CFP5	Nexperia	PMEG3030EP,115
35	4	D12, D14, D16, D18	3.6V	DIODE ZENER 3.6V 200MW SOD323F	ON Semiconductor	MM3Z3V6C
36	4	D20, D21, D22, D23	BKIN	LED RED CLEAR 2SMD	Everlight Electronics Co Ltd	19-217/R6C-AL1M2VY/3T
37	1	D24	USR1	LED GREEN DIFFUSED 0603 SMD	OSRAM Opto Semiconductors Inc.	LP L296-J2L2-25-Z

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
38	1	D25	RST	LED RED CLEAR 2SMD	Everlight Electronics Co Ltd	19-217/R6C-AL1M2VY/3T
39	1	D26	USR2	LED GREEN DIFFUSED 0603 SMD	OSRAM Opto Semiconductors Inc.	LP L296-J2L2-25-Z
40	1	F1	MINISMDC075F/33-2	PTC RESET FUSE 33V 750MA 1812	Littelfuse Inc.	MINISMDC075F/33-2
41	14	FB1, FB2, FB3, FB4, FB5, L4, L5, L6, L7, L8, L9, L10, L11, L12	330Ohm@100MHz	FERRITE BEAD 330 OHM 0603 1LN	Murata Electronics	BLM18SG331TN1D
42	12	FB6, FB7, FB8, FB9, FB10, FB11, FB12, FB13, FB14, FB15, FB16, FB17	120Ohms@100MHz	FERRITE BEAD 120 OHM 0603 1LN	Murata Electronics	BLM18PG121SN1D
43	1	J1	FI-S25P-HFE	CONN HEADER SMD R/A 25POS 1.25MM	JAE Electronics	FI-S25P-HFE
44	1	J2	FI-S30P-HFE	CONN HEADER SMD R/A 30POS 1.25MM	JAE Electronics	FI-S30P-HFE
45	2	J3, J4	Conn 2X8 pitch 2.5mm	Headers & Wire Housings NANOFIT HDR RA DLR 16CKT TIN BLK	Molex	105314-1116
46	2	J5, J6	Con 2X3 Pitch 2.5mm	Headers & Wire Housings NanoFit RA Hdr TH DR 6Ckt 0.38um Au Blk	Molex	105314-1206
47	1	J7	Con 1X2 Pitch 2.5mm	CONN HEADER R/A 2POS 2.5MM	Molex	1053131102
48	1	J8	0430450818	CONN HEADER SMD 8POS 3MM	Molex	0430450818
49	3	J9, J12, J24	DB9-male connector	CONN D-SUB PLUG 9POS VERT SOLDER	Amphenol ICC (Commercial Products)	L717TSEH09POL2RM5
50	5	J10, J13, J26, J32, J34	GRPB021VWVN-RC	CONN HEADER .050" 2POS PCB GOLD	Sullins Connector Solutions	GRPB021VWVN-RC
51	7	J11, J14, J15, J25, J30, J31, J33	Jumper-Female	CONN JUMPER SHORTING 1.27MM GOLD	Sullins Connector Solutions	NPB02SVAN-RC

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
52	2	J16, J29	CON 3 Strip 1.27	CONN HEADER VERT 3POS 1.27MM	Harwin Inc.	M50-3530342
53	3	J17, J19, J22	Jumper_Female	CONN JUMPER SHORTING .100" GOLD	Sullins Connector Solutions	QPC02SXGN-RC
54	3	J18, J20, J23	con3-strip-male	CONN HEADER .100 STR 3POS	Wurth Electronics Inc.	61300311121
55	1	J21	MOR2	CONN TERM BLOCK 2.54MM 2POS	Phoenix Contact	1725656
56	2	J27, J28	MA01R100VABBR600	CONN RIGID SIDE STR 100 POS	JAE Electronics	MA01R100VABBR600
57	1	J35	FTR-102-02-S-D	CONN HEADER SMD 4POS 1.27MM	Samtec Inc.	FTR-102-02-S-D
58	9	L1, L14, L15, L16, L17, L18, L19, L20, L21	120Ohm@100MHz	FERRITE BEAD 120 OHM 0603 1LN	Wurth Electronics Inc.	742792625
59	2	L2, L3	15uH	Power Inductors - SMD 15uH Shld 20% 3.9A 76.7mOhms AECQ2	Coilcraft	XAL5050-153MEC
60	1	L13	10uH 3.5A	FIXED IND 10UH 3.5A 33 MOHM SMD	Wurth Electronics Inc.	744314101
61	1	Q1	PMPB100XPEAX	MOSFET P MOS DISCRETES	Nexperia	PMPB100XPEAX
62	1	Q2	PMPB55XNEAX	MOSFET N-CH 30V 3.8A 6DFN	Nexperia	PMPB55XNEAX

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
63	49	R1, R2, R14, R15, R19, R20, R24, R25, R27, R28, R54, R60, R84, R85, R87, R88, R91, R92, R93, R95, R97, R98, R99, R177, R184, R188, R190, R191, R192, R199, R222, R223, R224, R225, R226, R227, R230, R231, R232, R233, R234, R236, R237, R241, R242, R246, R247, R248, R249	0	RES SMD 0 OHM JUMPER 1/10W 0603	Panasonic Electronic Components	ERJ-3GEY0R00V
64	2	R3, R4	0	RES SMD 0 OHM JUMPER 1/8W 0805	Yageo	RC0805JR-070RL
65	5	R5, R6, R7, R8, R9	0	RES SMD 0 OHM JUMPER 1/8W 0805	Yageo	RC0805JR-070RL
66	3	R10, R94, R96	0	RES SMD 0 OHM JUMPER 1/8W 0805	Yageo	RC0805JR-070RL
67	9	R11, R66, R68, R70, R72, R74, R80, R89, R213	1k	RES SMD 1K OHM 1% 1/10W 0603	Yageo	RC0603FR-071KL

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
68	1	R12	330	Thick Film Resistors - SMD CRGCQ 0603 330R 1% SMD Resistor	TE Connectivity	CRGCQ0603F330R
69	7	R13, R201, R202, R207, R208, R214, R217	150	RES SMD 150 OHM 1% 1/10W 0603	Yageo	RC0603FR-07150RL
70	2	R16, R21	120	RES SMD 120 OHM 1% 0.4W 0805	Rohm Semiconductor	ESR10EZPF1200
71	17	R17, R18, R22, R23, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R200	10k	RES SMD 10K OHM 0.1% 1/10W 0603	Panasonic Electronic Components	ERA-3AEB103V
72	16	R26, R29, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R115, R122, R150, R157	100	RES SMD 100 OHM 1% 1/10W 0603	Yageo	RC0603FR-07100RP

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
73	25	R52, R53, R55, R56, R59, R64, R67, R81, R82, R83, R170, R178, R179, R185, R186, R187, R189, R193, R194, R197, R198, R235, R238, R243, R245	0	RES SMD 0 OHM JUMPER 1/10W 0603	Panasonic Electronic Components	ERJ-3GEY0R00V
74	2	R57, R58	5.1k	RES SMD 5.1K OHM 1% 1/10W 0603	Yageo	RC0603FR-075K1L
75	1	R65	2.87k	RES SMD 2.87K OHM 1% 1/10W 0603	Yageo	RC0603FR-072K87L
76	7	R69, R75, R76, R77, R79, R105, R140	0.0	RES SMD 0.0OHM JUMPER 1/10W 0603	Yageo	RC0603JR-070RL
77	3	R71, R73, R78	30k	RES SMD 30K OHM 0.1% 1/10W 0603	Panasonic Electronic Components	ERA-3AEB303V
78	1	R86	1.5k	RES SMD 1.5K OHM 1% 1/10W 0603	Yageo	RC0603FR-071K5L
79	1	R90	100k	RES SMD 100K OHM 5% 1/10W 0603	Yageo	RC0603JR-07100KL

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
80	24	R100, R103, R106, R107, R108, R109, R110, R113, R128, R135, R138, R141, R142, R143, R144, R145, R148, R163, R216, R218, R219, R220, R221, R229	10k	RES SMD 10K OHM 1% 1/10W 0603	Yageo	RC0603FR-0710KL
81	12	R101, R104, R111, R119, R124, R132, R136, R139, R146, R154, R159, R167	470R	RES 470 OHM 1% 1/10W 0603	Yageo	RC0603FR-07470RL
82	2	R102, R137	15k	RES SMD 15K OHM 1% 1/10W 0603	Yageo	RC0603FR-1015KL
83	8	R112, R118, R125, R130, R147, R153, R160, R165	12k	RES 12K OHM 1% 1/10W 0603	Yageo	RC0603FR-0712KL
84	8	R114, R121, R126, R133, R149, R156, R161, R168	18k	RES 18K OHM 1% 1/10W 0603	Yageo	RC0603FR-1018KL
85	4	R116, R123, R151, R158	750	RES SMD 750 OHM 1% 1/10W 0603	Yageo	RC0603FR-07750RL
86	4	R117, R127, R152, R162	1.5k	RES SMD 1.5K OHM 1% 1/10W 0603	Yageo	RC0603FR-071K5L

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
87	4	R120, R131, R155, R166	20k	RES 20K OHM 1% 1/10W 0603	Yageo	RC0603FR-1015KL
88	2	R129, R164	10k	RES 10K OHM 1% 1/10W 0603	Yageo	RC0603FR-1010KL
89	2	R134, R169	5.1k	RES SMD 5.1K OHM 0.1% 1/10W 0603	Yageo	RT0603BRD075K1L
90	6	R171, R172, R173, R174, R175, R176	510	RES SMD 510 OHM 1% 1/10W 0603	Vishay	CRCW0603510RFKEBC
91	4	R180, R181, R182, R183	33K	RES SMD 33K OHM 1% 1/10W 0603	Yageo	RC0603FR-0733KL
92	2	R195, R196	0	RES SMD 0 OHM JUMPER 1/10W 0603	Panasonic Electronic Components	ERJ-3GEY0R00V
93	4	R203, R204, R209, R210	3.3k	RES SMD 3.3K OHM 0.1% 1/10W 0603	Panasonic Electronic Components	ERA-3AEB332V
94	1	R215	2.2K	RES SMD 2.2K OHM 1% 1/10W 0603	Yageo	RC0603FR-072K2L
95	3	R239, R240, R244	0	RES SMD 0 OHM JUMPER 1/10W 0603	Panasonic Electronic Components	ERJ-3GEY0R00V
96	4	S1, S2, S3, S4	SCREW_M4X6	Screw, Taptite, M4, 6 mm, Bright Zinc, Steel, Pan Head Pozidriv	RS Pro	483-0158
97	4	SP1, SP2, SP3, SP4	SpacrM4X14	Tower,M4,14mm Female, Female	Harwin Inc.	R40-1001402
98	3	SW1, SW2, SW3	1437566-3	SWITCH TACTILE SPST-NO 0.05A 24V	TE Connectivity	1437566-3
99	1	SW4	1437566-3	SWITCH TACTILE SPST-NO 0.05A 24V	TE Connectivity	1437566-3
100	1	SWD1	FTSH-105-01-L-D-K	CONN HEADER 10POS DUAL .05" T/H	Samtec Inc.	FTSH-105-01-L-D-K
101	1	T1	BC846C	TRANS NPN 65V 0.1A SOT-23	ON Semiconductor	BC846CMTF
102	2	TP0, TP9	TESTPOINT	TEST POINT 1MM SMD PADSTASCK	/	/
103	2	TP1, TP5	CAN_Tx	TEST POINT 1MM SMD PADSTASCK	/	/
104	2	TP2, TP6	CAN_H	TEST POINT 1MM SMD PADSTASCK	/	/

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
105	2	TP3, TP7	CAN_L	TEST POINT 1MM SMD PADSTASCK	/	/
106	39	TP4, TP8, TP16, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP35, TP36, TP37, TP38, TP39, TP40, TP41, TP42, TP43, TP44, TP45, TP46, TP47, TP48, TP49, TP50, TP51, TP52, TP53, TP54, TP55, TP56, TP57, TP58, TP59, TP60, TP61, TP62	CAN_Rx	TEST POINT 1MM SMD PADSTASCK	/	/
107	1	TP11	SWDBG	TEST POINT 1MM SMD PADSTASCK	/	/
108	1	TP12	CSN	TEST POINT 1MM SMD PADSTASCK	/	/
109	1	TP13	CLK	TEST POINT 1MM SMD PADSTASCK	/	/
110	1	TP14	MOSI	TEST POINT 1MM SMD PADSTASCK	/	/
111	1	TP15	MISO	TEST POINT 1MM SMD PADSTASCK	/	/
112	1	TP17	GND	TEST POINT 1MM SMD PADSTASCK	/	/
113	1	TP18	VDD_LV	TEST POINT 1MM SMD PADSTASCK	/	/
114	1	TP19	VDD_HV	TEST POINT 1MM SMD PADSTASCK	/	/
115	1	TP20	VDD_LV_S	TEST POINT 1MM SMD PADSTASCK	/	/
116	1	TP21	PMOS	TEST POINT 1MM SMD PADSTASCK	/	/

ItemA7:G7	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
117	1	TP22	VLX	TEST POINT 1MM SMD PADSTASCK	/	/
118	1	TP23	VDD_LV_SMPS	TEST POINT 1MM SMD PADSTASCK	/	/
119	1	TP24	NMOS	TEST POINT 1MM SMD PADSTASCK	/	/
120	1	TP25	VDD_LDO1	TEST POINT 1MM SMD PADSTASCK	/	/
121	1	TP26	VDD_LDO2	TEST POINT 1MM SMD PADSTASCK	/	/
122	2	U1, U2	TCAN330GD	CAN Interface IC 3.3-V CAN Transceivers with CAN FD (Flexible Data Rate) 8-SOIC -40 to 125	Texas Instruments	TCAN330GD
123	2	U10, U13	TSB514IYPT, TSSOP-14L	RAIL-TO-RAIL INPUTS AND OUTPUTS,	ST	TSB514IYPT
124	1	U3	SPSB100,	Power Managment,AEC-Q100,Current 3A	ST	SPSB100
125	1	U5	LD1117DT33TR, DPAK	IC REG LINEAR 3.3V 800MA DPAK	ST	LD1117DT33TR
126	2	U6, U7	ESDA5V3LY, SOT23-3L	TVS DIODE 3VWM 19VC SOT23-3L	ST	ESDA5V3LY
127	1	U8	ESDA6V1LY	TVS DIODE 5.2VWM 16VC SOT23-3L	ST	ESDA6V1LY
128	2	U11, U14	TSV911ILT	IC OPAMP GP 8MHZ RRO SOT23-5	ST	TSV911ILT
129	2	U12, U16	TSB582IYDT	DUAL Operation Amplify	ST	TSB582IYDT
130	1	U15	ST3232EBTR	IC DRVR/RCVR RS232 ESD 16-TSSOP	ST	ST3232EBTR
131	1	U17	STM6315RDW13F	IC MPU RESET CIRC 2.63V SOT-143	ST	STM6315RDW13F
132	1	U9	SR5E1E7-AA-ES	ARM Microcontrollers 32 Bit- MCU 176 Pin	ST	SR5E1E770C30F00X
133	1	Y1	40 MHz	CRYSTAL 40.0000MHZ 18PF SMD	Abracon LLC	ABM8-40.000MHZ-B2-T
134	1	PCB	FR4-6 Layer	FR4-6 Layer-TG140-thickness 40micron external 35 micron internal	Massive PCB	DSC-CLU

10 Board versions

Table 13. **STEVAL-TTM007A versions**

Finished good	Schematic diagrams	Bill of materials
STEVAL$TTM007AA (1)	STEVAL$TTM007AA schematic diagrams	STEVAL$TTM007AA bill of materials

1. *This code identifies the STEVAL-TTM007A evaluation board first version.*

11 Regulatory compliance information

Notice for US Federal Communication Commission (FCC)

For evaluation only; not FCC approved for resale

FCC NOTICE - This kit is designed to allow:

(1) 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

(2) 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 3.1.2.

Notice for Innovation, Science and Economic Development Canada (ISED)

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

Notice for the European Union

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2015/863/EU (RoHS).

Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032).

Revision history

Table 14. **Document revision history**

Date	Version	Changes
17-Sep-2024	1	Initial release.

Contents

List of figures

List of tables