Option Modules Manual

Option Modules for the TSD and TSP drive series

Enhance the functionality of the standard *TSD* and *TSP* drives with hardware *Option Modules*.

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1. Introduction

Up to two *Option Modules* can be installed into one *TSD* drive. The *TSP* drives currently support only one *Option Module*.

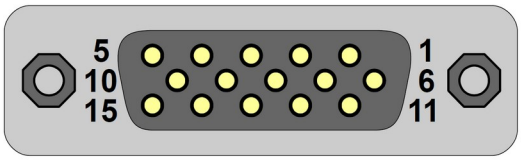

Figure 1: Option Modules connector

Installed modules are statically mapped to the axes of the drive. A module installed at *X10* belongs to *Axis0* and one installed at *X11* belongs to *Axis1*.

If only one module is installed, it is at *X10* (*Axis0*) by default.

The *Status X10* and *Status X11 LEDs* show the status of each *Option Module*.

LED	status
dark	module not present
red-steady	start-up failure, fatal
red-blink	error in operation
green-steady	operational

1.1. Integration in TAM System Explorer

Installed *Option Modules* are shown in the *Topology* tree under the Station node.

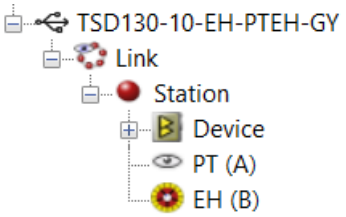

Figure 2: Installed Option Modules PT and EH

Depending on the module installed, an OptionModule node is shown within the Axes Tree in Parameters, Commands and Signals. The node appears in the axis, where the *Option Module* is installed.

Persistent Configuration: Axes[].Parameters.OptionModule

Commands: Axes[].Commands.OptionModule

Signals: Axes[].Signals.OptionModule

Some *Option Modules* don't show additional *Registers* (i.e. additional encoders). Possible reasons are:

- Corresponding Registers are already embedded in the Device tree.
- The module doesn't offer customer accessible Registers.

2. Additional Encoders

The pinouts and electrical specifications are identical to the standard encoder inputs *X20*, *X21*. Refer to the hardware manual of the drive [3], [4], [5] for compatible encoder modes.

The additional encoder may be used as a second feedback, if two encoders feed one axis. The motor commutation might be done with this additional encoder, or with the standard encoder. All supported combinations are configurable, using the EncoderTopology selector as detailed in the application note *AN107*.

2.1. EN (TOE1)

This module implements a standard encoder input, identical to the inputs *X20* and *X21*, available on the drive. Refer to the hardware manual of the drive [3], [4], [5] for the electrical specifications.

2.2. EH (TOE2)

This module implements a high speed encoder input for analog sin/cos encoders with 18bit interpolation up to 2MHz and quadrature interpolation from 2MHz to 10MHz. All feedback channels, except the analog encoder, remain identical to the standard encoder, as specified in the hardware manual of the drive [3], [4], [5].

2.3. Pulsing Unit (Software Option)

Enables high frequency, position based, pulse generation functionality for *Option Module* encoders *EN* and *EH*. More information is available in [2].

This is a paid *Software Option* with order code *PU*, that can be activated subsequently.

3. AN – Analog Inputs (TOA4)

The *AN* module implements eight bipolar analog inputs. Please note that some reference inputs are shared.

Parameter	Axes[].Parameters.OptionModule.AN_Range[]			Unit
	Bipolar10V	Bipolar5V	Bipolar2V5	
Bipolar input Range **Reference Input Range**	±10 -0.7 to 1.9	±5 -0.1 to 2.7	±2.5 -0.1 to 3.1	V V
Resolution (no missing codes) **Accuracy**	305 ±25	152 ±18	76 ±14	µV mV
Cut-off frequency	22	14	11	kHz
Input Voltage Absolute Maximum	±28			V

The pin assignments of the module connector (see Figure 1):

Pin	Signal	Notes
1	Gnd	Analog ground, connection to peripheral signal ground mandatory!
7 2	AnalogIn0 AnalogIn0Ref	
8 3	AnalogIn1 AnalogIn1Ref	
9 4	AnalogIn2 AnalogIn2Ref	
10 5	AnalogIn3 AnalogIn3Ref	
11 12 6	AnalogIn4 AnalogIn5 AnalogIn45Ref	The inputs 4 and 5 share the same reference ground
13 14 15	AnalogIn6 AnalogIn7 AnalogIn67Ref	The inputs 6 and 7 share the same reference ground

In the software interface, the measured voltage of the analog inputs 0..7 are available at

Axes[].Signals.OptionModule.AnalogIn[i]

at a 100 kHz sampling rate. The *AN* modules are configured using:

```
Axes[].Parameters.OptionModule.AN_Range[i]          Range ±10V, ±5V or ±2.5V
Axes[].Parameters.OptionModule.AN_Gain[i]           Gain between AnalogIn and the measured voltage
Axes[].Parameters.OptionModule.AN_FirFilterFpga     3dB bandwidth of 100kHz down to 500Hz
```

4. AH – High-Speed Analog Input (TOA2)

This module supports two high-speed, low impedance differential analog inputs.

Note: Customer specific implementation is required. The signal processing is made internally on the drive at 5MHz (FPGA). The output data is transmitted in bursts at a rate of 10kHz. Contact Triamec Motion AG for further information.

Specification	Value	Unit
Differential input range Input impedance (differential)	±1.2 120	V Ohm
Resolution	16	bit
Sampling frequency	40	MHz
Cut-off frequency	5	MHz
Input voltage absolute range	0 to 3.3	V

Application examples (customer specific):

- Lock-In amplifier
- Signal demodulation

Connect the following signals to the option module connectors *X10* or *X11*. See Figure 1 for the pin assignments of the module connector.

Pin	Signal	Notes	
1	+5VDC	5V Supply	
2	ChA+	Channel A positive	
3	ChB+	Channel B positive	
4			
5			
6	Gnd	Supply Ground	
7	ChA-	Channel A negative	
8	ChB-	Channel B negative	
9			
10			
11	EncIn0	TTL Level Input No. 0 (max 5VDC Input)	see TTL Inputs connection in [3], [4], [5]
12	EncIn1	TTL Level Input No. 1 (max 5VDC Input)	see TTL Inputs connection in [3], [4], [5]
13	EncIn2	TTL Level Input No. 2 (max 5VDC Input)	see TTL Inputs connection in [3], [4], [5]
14	EncIn3	TTL Level Input No. 3 (max 5VDC Input)	see TTL Inputs connection in [3], [4], [5]
15	Gnd	Signal Ground	

5. FF – Fast Fourier Transform (TOF1)

The *FF* module converts time domain signals into the frequency domain. The module has one ADC channel input and processes the signal through a *Xilinx FFT IP* core. The spectrum lines can be recorded and scoped with a rate of 100kHz with the Tam System Explorer. See application note AN148 [1] for more information.

Specification	Value	Unit
Differential input range Input impedance (differential)	1.366 120	Vpp Ohm
Resolution	16	bit
Sampling frequency	10	MHz
Cut-off frequency	2.5	MHz
Input voltage absolute maximum	0 to 3.3	V

Connect the following signals to the option module connectors *X10* or *X11*. See Figure 1 for the pin assignments of the module connector.

Pin	Signal	Notes
1	+5VDC	5V Supply
2	ChA+	Channel A positive
3	Reserved	
4	Reserved	
5	Reserved	
6	Gnd	Supply Ground
7	ChA-	Channel A negative
8	Reserved	
9	Reserved	
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14	Reserved	
15	Gnd	Signal Ground

6. AO – Analog Outputs (TOA3)

Specification	Value	Unit
Output Range Bipolar Mode Output Range Unipolar Mode Minimum load	±5V, ±10V, ±10.8V 5V, 10V, 10.8V 2	V V kOhm
Resolution Precision (Total unadjusted error) Update Rate Settling Time (full step)	16 Max 0.3 10 (interpolated to 200) 10	Bit % of full range kHz µs

Connect the following signals to the option module connectors *X10* and *X11*, see also Figure 1:

Pin	Signal	Notes
1	unused	
2	AnalogOut0	DAC out
3	AnalogOut1	
4	AnalogOut2	
5	AnalogOut3	
6	Gnd	DAC Gnd, these five grounds are internally connected to each other.
7	Gnd	
8	Gnd	
9	Gnd	
10	Gnd	
11	ChA+	Customer specific extension, do not connect
12	ChA-	
13	ChB+	
14	ChB-	
15	Gnd	Signal Gnd

In the software interface, the analog outputs 0..3 are set at:

Axes[].Commands.OptionModule.AnalogOut[i]

at a 10 kHz sampling rate. The modules are configured using:

Axes[].Parameters.OptionModule.AO_Range[i]	Select from Unipolar and Bipolar ranges Off, ±5V, ±10V and ±10.8V.
Axes[].Parameters.OptionModule.AO_Gain[i]	Choose the gain, which is the ratio between AnalogOut and the actual voltage.

7. UN – Universal A/D-I/O (TOU1)

The *UN* module implements four analog inputs, two analog outputs and a *PWM* output.

7.1. Inputs

The analog inputs (single-ended) are available on the option module connectors *X10* and *X11*, see also Figure 1.

Pin	Signal	Input Range	Max. Input Voltage	Resolution	Bandwidth
7	AnalogIn0	±5V	±30V	166µV	1.5kHz
2	AnalogIn1	±5V	±30V	166µV	1.5kHz
8	AnalogIn2	±5V	±30V	166µV	1.5kHz
3	AnalogIn3	±5V	±30V	166µV	1.5kHz
6	Analog ground				

The measured voltage of analog inputs 0..3 is available at:

Axes[].Signals.OptionModule.AnalogIn[i]

The sampling rate is 10 kHz. There are no configuration registers for this function.

7.2. Outputs

Pin	Signal	Output Range	Frequency	Resolution
6	Analog ground			
11	AnalogOut0	0 - 3.3V	10kHz	12 bit
12	AnalogOut1	0 - 3.3V	10kHz	12 bit
13	PWM	3.3V, 0 - 0.0001s	10kHz	21 ns
15	Digital ground			

The analog outputs 0..1 are controlled by setting the voltage in the registers:

Axes[].Commands.OptionModule.AnalogOut[i]

The *PWM* is not synchronized to the master bus clock. Use the pulse train module *PT*, if a synchronized *PWM* is required. The duty cycle is controlled through the register:

Axes[].Commands.OptionModule.PwmOut

The command value range is 0.0f to 1.0f, corresponding to 0% – 100% duty cycle. The command resolution is 0.00021f.

8. PT – Pulse Train Option (TOF2)

This module implements a pulse generator for pulse, trigger and motion positioning signals. It may be used as control output for laser modules, or as encoder emulation, etc.

The module generates two signals A and B. Each signal is wired to both single ended and differential outputs of the option module connector as shown in Table 1 (see Figure 1 for the connector image).

The *Mode* (see also Table 2) defines the behavior of the module and how the pulse generator can be parameterized. The *Mode* can be set with the following register:
Axes[].Parameters.OptionModule.PT_Mode

The pulse parametrization is commanded in the following registers:
Axes[].Commands.OptionModules.AnalogOut[]

Pin	Signal	Description
1	Vdd	Output 5.2V max 250mA
5	A +	Differential 3.3V
10	A -	
4	B +	Differential 3.3V
9	B -	
11	E0	=A, Single-ended 3.3V
12	E1	=B, Single-ended 3.3V
13	E2	=A, Single-ended 3.3V
14	E3	=B, Single-ended 3.3V
15	DGnd	Digital ground

Table 1: Pinout / Signals of Pulse Train Module

With the *Register* Axes[].Parameters.OptionModule.PT_InvertedOutput the output logic is inverted.

Mode	Variables	Description
Disabled		The unit is disabled and the outputs A, B and E0 to E3 are 0. The inverted outputs are 1.
PulseTimer	AnalogOut[0] = delayA [s] AnalogOut[1] = durationA [s] AnalogOut[2] = delayB [s] AnalogOut[3] = durationB [s]	These variables are floating point. The resolution of the output signal is 10ns. Digits below 10ns are truncated. The pulse generation is related to the 10kHz cycle of the drive. With delayA and delayB the delay of the next pulses can be set, in regard of the next 10kHz time frame. The parameters durationA and durationB define the duration of the pulses. If delay+duration > 100µs it will prolong into the next 100µs time frame. A pulse will fire each 100µs cycle while a duration is set >0s. The pulse has to be configured in the cycle before it shall fire (see also Figure 3). Value constraints are: 0 ≤ delay < 100µs 0 < duration ≤ 100µs

Table 2: Modes of operation of the PT module

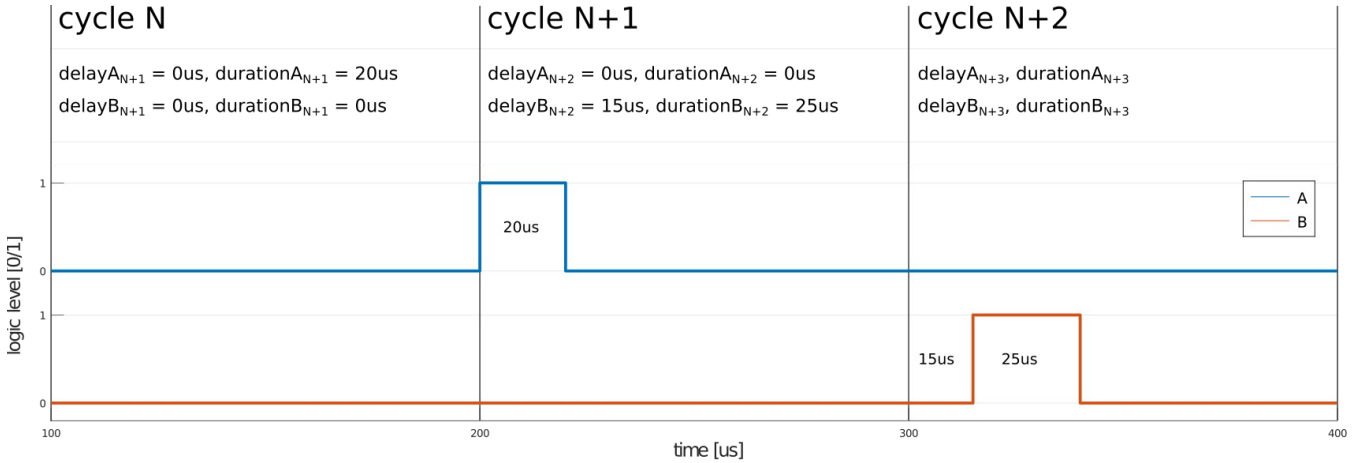

Figure 3: Visualization of TimedPulse parametrization and corresponding output signal.

More modes of operation are possible with the Pulse Train Module. A selection of preliminary functionalities is described in Table 3 below. Please contact *Triamec Motion AG*, for more information.

Functionality (preliminary)	**Description**
Encoder position	In position modes the number of output pulses is the delta between actual set point and previous set point. The Pulse Train Module equally distributes the pulses and ensures an exact pulse count.
Pulse and direction position	
up/down position	
encoder velocity	In velocity modes the number of output pulses is given by the value of a velocity set point. The pulse frequency could be *f = 100kHz / downsampling * setpoint*.
pulse and direction velocity	
up/down velocity	

Table 3: Preliminary functionality of PT Module

References

[1] “Fast Fourier Transform”, AN148_FF_FastFourierTransform_EP002.pdf, Triamec Motion AG, 2023.
[2] “Pulsing Unit”, AN152_PulsingUnit_EP001.pdf, Triamec Motion AG, 2023.
[3] “Hardware Manual, TSD80-06, TSD80-10, TSD80-15, TSD130-10, Revisions 4 and 5”, HWTSD80-TSD130_4-5_HardwareManual_EP015.pdf, Triamec Motion AG, 2024
[4] “Hardware Manual, TSD350-10, TSD350-15, Revisions 2”, HWTSD350_2_HardwareManual_EP004.pdf, Triamec Motion AG, 2024
[5] “Hardware Manual, TSP700-10, TSP700-20, TSP700-40, Revisions 0 to 2”, HWTSP700_0-2_HardwareManual_EP008.pdf, Triamec Motion AG, 2024

Revision History

Version	Date	Editor	Comment
007	2021-12-22	mvx	Updated the PT interface as of firmware release 4.13 and newer.
008	2022-01-10	sm	General formatting overhaul, update PT description
009	2022-03-25	sm	Update template, rename file and title to match convention, change owner
010	2022-06-27	sm	Clarify PT description.
011	2022-07-12	sm	PT: Fix differential annotation in pinout
012	2022-08-18	dg	AO: Filter register is not available for AO module.
013	2022-09-20	sm	Update introduction chapter
014	2022-11-04	re	Update FF module
015	2023-02-09	dg	Update FF module
016	2023-02-14	sm	AN: add missing analog ground
017	2023-04-27	sm	Add Pulsing Unit info for Encoders
018	2023-06-01	sm	New analog outputs on UN module with FW ≥4.19
019	2023-06-02	sm	EH module update
020	2024-04-18	ab	Added TTL inputs connection hints in TOA2 and references to hardware manuals

Triamec Motion AG
Lindenstrasse 16
6340 Baar / Switzerland

Phone +41 41 747 4040
Email info@triamec.com
Web www.triamec.com

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