ADVANCED MOTION CONTROLS

CANopen PVT Example

Introduction

This Application Note gives an example of how to configure and use PVT mode to command a simple position move with a trapezoidal velocity profile. The motor is commanded from 0 to a position of 80,000 counts in 12 seconds where the accel and decel is limited to 2500 counts/s^2 and the max velocity during the move is 10,000 counts/s. A scope plot of the move, along with the PVT points can be found on page 3 of this application note. This example can be extended to any position trajectory by using different PVT points.

Note: The 'T' in the example frames is the message time stamp and 'ΔT' is the time difference between successive message. Both are in units of miliseconds.

Note: SDO size indication is disabled in this example.

Transition to the Switch On Disabled State

Read Status Word 6041.h to verify which state the drive is in.

COB-ID	# of Bits	Message	T	ΔT
601	8	40 41 60 00 00 00 00 00	704	704
581	8	42 41 60 00 37 06 00 00	705	1

Write the appropriate data to the Control Word 6040h to place drive in Switch on Disabled State.

COB-ID	# of Bits	Message	T	ΔT
601	8	22 40 60 00 04 00 00 00	705	0
581	8	60 40 60 00 00 00 00 00	706	1

Configure the 24th RPDO

First transition the drive into the pre-operational NMT state to allow for PDO configuration.

COB-ID	# of Bits	Message	T	ΔT
000	8	80 01 00 00 00 00 00 00	706	0

The 24th RPDO is used to write PVT points to the PVT buffer.To configure the 24th RPDO, set the COB-ID of the 24th RPDO (COB-ID is 501h in this example) and set bit 31 to 0 to turn the RPDO on.

COB-ID	# of Bits	Message	ΔT	ΔD
601	8	22 17 14 01 01 05 00 00	707	0
581	8	60 17 14 01 00 00 00 00	708	1

In most cases, the transmission type for the 24th RPDO should be asynchronous. This is so that as soon as a node receives a PVT point from the host, it is immediately written to the PVT buffer. This is the default setting in the drive, however this can be set by writing FEh or FFh to sub-index 2 of the 24th RPDO Communication Object Parameter (1417.02h).

Set Mode of Operation to PVT Mode

Write a 7h to 6060h to put the drive in PVT mode.

COB-ID	# of Bits	Message	T	ΔT
601	8	22 60 60 00 07 00 00 00	708	0
581	8	60 60 60 00 00 00 00 00	709	1

Set Buffer Threshold Warning Level

A buffer threshold warning will occur when the number of PVT points in the PVT buffer is less than the value in the Buffer Threshold Warning object 2048.01h. The value is 10 (Ah) in this example.

COB-ID	# of Bits	Message	T	ΔT
601	8	22 48 20 01 0A 00 00 00	709	0
581	8	60 48 20 01 00 00 00 00	710	1

Configure the 24th TPDO

This example has the 24th TPDO transmit when the number of PVT points in the buffer is less than the value in the Buffer Threshold Warning object 2048.01h. This triggers the host to send more PVT points to fill the PVT buffer.

This occurs when the transmission type for the 24th TPDO is asynchronous which is the default setting in the drive. This can be achieved however by writing FEh or FFh to sub-index 2 of the 24th TPDO Communication Object Parameter (1817.02h).

The TPDO will transmit once and can trasmit again only after loading more points into the PVT buffer such that the number of points is greater than the buffer threshold warning level. The data in the TPDO is the number of points currently in the buffer.

Set the COB-ID of the 24th TPDO (COB-ID is 381h in this example) and set bit 31 to 0 to turn the TPDO on.

COB-ID	# of Bits	Message	T	ΔT
601	8	22 17 18 01 81 03 00 00	710	0
581	8	60 17 18 01 00 00 00 00	711	1

Other PVT Setup

Transition the drive into the operational NMT state to allow use of PDOs

COB-ID	# of Bits	Message	T	ΔT
000	8	01 01 00 00 00 00 00 00	711	0

Write a 0 to the PVT Input Method object 2048.02 if the PVT points are absolute. Write a 1 for incremental PVT points. This example uses absolute PVT points.

COB-ID	# of Bits	Message	T	ΔT
601	8	22 48 20 02 00 00 00 00	711	0
581	8	60 48 20 02 00 00 00 00	712	1

Clear the PVT buffer by writing a 0 to the Buffer Clear object 60C4.06h.

COB-ID	# of Bits	Message	T	ΔT
601	8	22 C4 60 06 00 00 00 00	712	0
581	8	60 C4 60 06 00 00 00 00	713	1

Enable the Drive

The following frames alternately write to the Control Word and read the Status word until the drive is in the Operation Enabled state.

COB-ID	# of Bits	Message	T	ΔT
601	8	22 40 60 00 06 00 00 00	713	0
581	8	60 40 60 00 00 00 00 00	714	1
601	8	40 41 60 00 00 00 00 00	764	50
581	8	42 41 60 00 21 06 00 00	765	1
601	8	22 40 60 00 0F 00 00 00	815	50
581	8	60 40 60 00 00 00 00 00	816	1

The following message checks to see if the drive is in the Fault state. The message data below indicates the drive is in the Operation Enabled State which means the drive is enabled.

COB-ID	# of Bits	Message	T	ΔT
601	8	40 41 60 00 00 00 00 00	866	50
581	8	42 41 60 00 37 06 00 00	866	0

Load the PVT Buffer

The PVT buffer is a FIFO buffer that can contain up to 15 PVT points. The first 15 PVT points are written to the buffer using the 24th RPDO.

COB-ID	# of Bits	Message	T	ΔT
501	8	4E 00 00 71 02 00 FA 00	866	0
501	8	38 01 00 E2 04 00 FA 01	867	1
501	8	BF 02 00 53 07 00 FA 02	867	0
501	8	E2 04 00 C4 09 00 FA 03	867	0
501	8	A1 07 00 35 0C 00 FA 04	867	0
501	8	FC 0A 00 A6 0E 00 FA 05	867	0
501	8	F4 0E 00 17 11 00 FA 06	867	0
501	8	88 13 00 88 13 00 FA 07	867	0
501	8	B8 18 00 F9 15 00 FA 08	868	1
501	8	84 1E 00 6A 18 00 FA 09	868	0
501	8	ED 24 00 DB 1A 00 FA 0A	868	0
501	8	F2 2B 00 4C 1D 00 FA 0B	868	0
501	8	93 33 00 BD 1F 00 FA 0C	868	0
501	8	D0 3B 00 2E 22 00 FA 0D	868	0
501	8	AA 44 00 9F 24 00 FA 0E	868	0

Start PVT

COB-ID	# of Bits	Message	T	ΔT
500	8	00 00 00 00 00 00 00 00	868	0

In this example, the buffer threshold warning level is 10 which means when the 10th PVT point is consumed, the 24th TPDO transmits and tells you there are 9 points left in the buffer. When this occurs, we know to send 6 more PVT points to fill the (15 point) buffer.

This continues until all of the PVT points are consumed. To end a PVT move, a PVT stop point is sent to the PVT buffer. The PVT stop point has the same position as the previous PVT point but has 0 for both the velocity and time. The integrity counter however is still incremented.

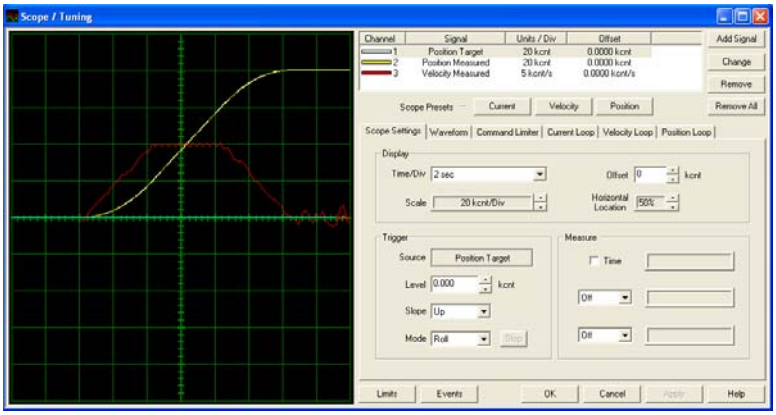
If the PVT stop point is not sent, an NMT error will occur indicating a PVT Buffer Underflow. This is because the drive is still looking for more PVT points.

COB-ID	# of Bits	Message	T	ΔT
381	4	09 00 00 00	2375	1507
501	8	20 4E 00 10 27 00 FA 0F	2375	0
501	8	E4 57 00 10 27 00 FA 10	2376	1
501	8	A8 61 00 10 27 00 FA 11	2376	0
501	8	6C 6B 00 10 27 00 FA 12	2376	0
501	8	30 75 00 10 27 00 FA 13	2376	0
501	8	F4 7E 00 10 27 00 FA 14	2376	0

COB-ID	# of Bits	Message	T	ΔT
381	4	09 00 00 00	3875	1499
501	8	B8 88 00 10 27 00 FA 15	3875	0
501	8	7C 92 00 10 27 00 FA 16	3876	1
501	8	40 9C 00 10 27 00 FA 17	3876	0
501	8	04 A6 00 10 27 00 FA 18	3876	0
501	8	C8 AF 00 10 27 00 FA 19	3876	0
501	8	8C B9 00 10 27 00 FA 1A	3876	0
COB-ID	# of Bits	Message	T	ΔT
381	4	09 00 00 00	5375	1499
501	8	50 C3 00 10 27 00 FA 1B	5376	1
501	8	14 CD 00 10 27 00 FA 1C	5376	0
501	8	D8 D6 00 10 27 00 FA 1D	5376	0
501	8	9C E0 00 10 27 00 FA 1E	5376	0
501	8	60 EA 00 10 27 00 FA 1F	5376	0
501	8	D5 F3 00 9F 24 00 FA 20	5376	0
COB-ID	# of Bits	Message	T	ΔT
381	4	09 00 00 00	6875	1499
501	8	AF FC 00 2E 22 00 FA 21	6875	0
501	8	EC 04 01 BD 1F 00 FA 22	6875	1
501	8	8E 0C 01 4C 1D 00 FA 23	6875	0
501	8	92 13 01 DB 1A 00 FA 24	6875	0
501	8	FB 19 01 6A 18 00 FA 25	6876	1
501	8	C7 1F 01 F9 15 00 FA 26	6876	0
COB-ID	# of Bits	Message	T	ΔT
381	4	09 00 00 00	8375	1499
501	8	F8 24 01 88 13 00 FA 27	8375	0
501	8	8B 29 01 17 11 00 FA 28	8375	0
501	8	83 2D 01 A6 0E 00 FA 29	8375	0
501	8	DE 30 01 35 0C 00 FA 2A	8376	1
501	8	9E 33 01 C4 09 00 FA 2B	8376	0
501	8	C0 35 01 53 07 00 FA 2C	8376	0
COB-ID	# of Bits	Message	T	ΔT
381	4	09 00 00 00	9875	1499
501	8	47 37 01 E2 04 00 FA 2D	9875	0
501	8	31 38 01 71 02 00 FA 2E	9875	0
501	8	80 38 01 00 00 00 FA 2F	9875	0
501[1]	8	80 38 01 00 00 00 00 30	9876	1

1. PVT stop point

Scope Plot of PVT Move



Raw PVT Points

Note: Units for position, velocity, and time are counts, counts/s and miliseconds respectively.

#	P	V	T
1	78	625	250
2	312	1250	250
3	703	1875	250
4	1250	2500	250
5	1953	3125	250
6	2812	3750	250
7	3828	4375	250
8	5000	5000	250
9	6328	5625	250
10	7812	6250	250
11	9453	6875	250
12	11250	7500	250
13	13203	8125	250
14	15312	8750	250
15	17578	9375	250
16	20000	10000	250
17	22500	10000	250
18	25000	10000	250
19	27500	10000	250
20	30000	10000	250
21	32500	10000	250
22	35000	10000	250
23	37500	10000	250
24	40000	10000	250
25	42500	10000	250
26	45000	10000	250
27	47500	10000	250
28	50000	10000	250
29	52500	10000	250
30	55000	10000	250
31	57500	10000	250
32	60000	10000	250
33	62421	9375	250
34	64687	8750	250
35	66796	8125	250
36	68750	7500	250
37	70546	6875	250
38	72187	6250	250
39	73671	5625	250
40	75000	5000	250
41	76171	4375	250
42	77187	3750	250
43	78046	3125	250
44	78750	2500	250
45	79296	1875	250
46	79687	1250	250
47	79921	625	250
48	80000	0	250
49[1]	80000	0	0

1. PVT stop point