Application Not

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3-phase Hall Sensor Decoder TPU Function (3HD)

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Functional Overview

The 3-phase Hall Sensor Decoder (3HD) TPU Function is useful for decoding information from a Hall sensor signal in a motion control system. The function uses three input channels to obtain this information for the CPU:

- position in one of six sectors,
- direction,
- period of last revolution updated 6-times per revolution,
- revolution counter.

Figure 1 illustrates the functionality.

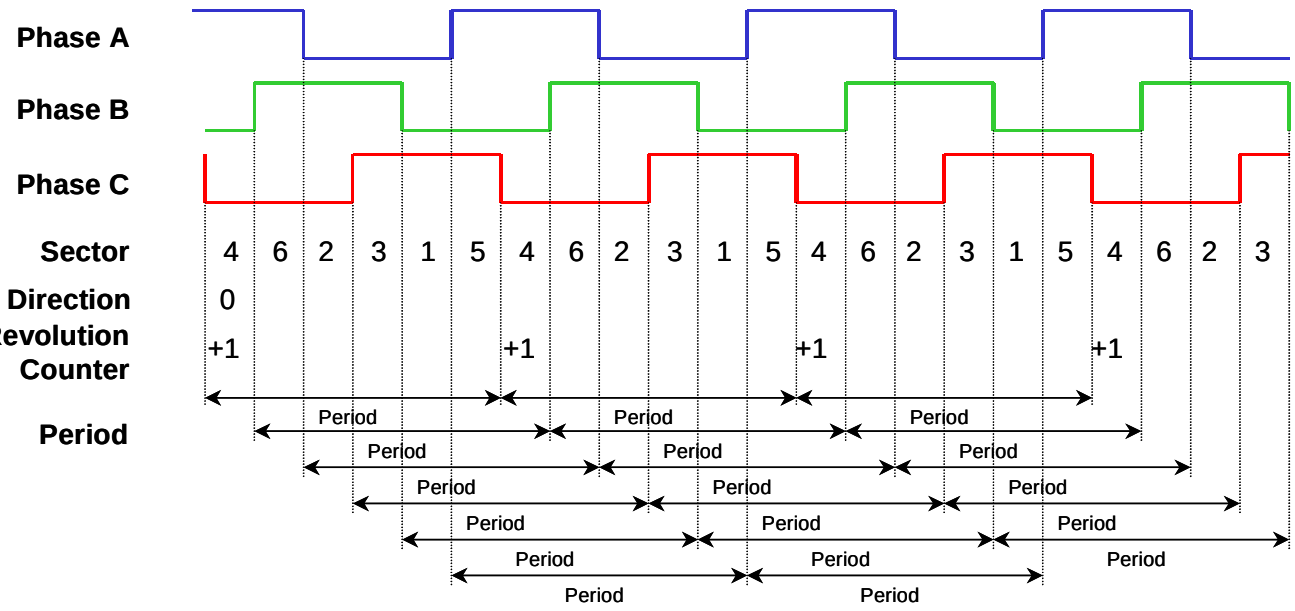

Figure 1. Signals processed by 3HD TPU function and corresponding values

Function Configuration

Unlike most of the functions in the MC TPU Library, the 3HD is single-function, and not a member of a function set. There are no restrictions on channel assigment – it can run on any three channels.

Table 1 shows the configuration options and restrictions.

Table 1. 3HD TPU function configuration options and restrictions

TPU function	How many channels	Assignable channels
3HD	3	any 3 channels

The three Hall sensor signals are called Phase A, Phase B and Phase C. The Host Sequence (HSQ) bit 0 is used to determine Phase C, which updates the revolution counter in addition to other processing activities common to all phases. The HSQ is also used for other configuration options – refer to the detailed function descriptions.

Table 2 shows an example of configuration. The Phase A signal is connected to channel 0, Phase B to channel 1 and Phase C to channel 2. The TCR1 clock is selected for all timing operations.

Table 2. Example of configuration

Channel	TPU function	HSQ	Priority
0	3HD	00	middle
1	3HD	00	middle
2	3HD	01	middle

In this configuration, when no other functions run on the same TPU, the 3HD can receive and process input transitions at a rate of up to 690 kcounts per second at 40MHz IMB clock.

Table 3 shows the TPU function code sizes.

Table 3. TPU function code sizes

TPU function	Code size
3HD	63 μ instructions + 8 entries = 71 long words

Configuration Order

The CPU configures the TPU as follows.

1. Disables the channels by clearing the two channel priority bits on each channel used (not necessary after reset).
2. Selects the channel functions on all used channels by writing the function numbers to the channel function select bits.
3. Initializes function parameters. The parameters PinAdrPrev_A, PinAdrNext_A, PinAdrPrev_B, PinAdrNext_B and RC initialization value must be set before initialization.
4. Set the HSQ (Host Sequence) bits to identify Phase C channel and to select TCR1 or TCR2 clock. The clock selection must be the same on all channels.
5. Issues an HSR (Host Service Request) type %10 all 3HD channels to initialize decoding.
6. Enables servicing by assigning high, middle or low priority to the channel priority bits. All Phase A, Phase B and Phase C channels should be assigned the same priority.

NOTE: *A CPU routine that configures the TPU can be generated automatically using the MPC500_Quick_Start Graphical Configuration Tool.*

Detailed Function Description

3-phase Hall Sensor Decoder (3HD)

The 3HD operates on three channels and processes the incoming Hall sensor signals. As a result of this processing, the Sector parameter gets a value that reflects the position of a motion system in one of six sectors. The state of the Hall sensor signals and the corresponding Sector value is listed in **Table 4**.

Table 4. Hall sensor signal states and corresponding Sector value

Phase A	Phase B	Phase C	Sector
1	0	0	4
1	1	0	6
0	1	0	2
0	1	1	3
0	0	1	1
1	0	1	5
0	0	0	0
1	1	1	7

A Sector value of 0 or 7 indicates an illegal state of the Hall sensor signals.

The Sector value history determines the direction of the motion system. The Direction parameter can be assigned a value of 0 or 1. See **Table 5**.

Table 5. Sector value sequence and corresponding Direction value

Sector value sequence	Direction
4, 6, 2, 3, 1, 5, 4,...	0
4, 5, 1, 3, 2, 6, 4,...	1

The Period value is calculated each time the sector is changed. The Period value is the TCR time of last revolution. It is measured from the last edge of similar type (low-high / high-low), on the same channel, to the current edge – see **Figure 1** and **Figure 2**. This method eliminates inaccuracies in the Hall sensor signals. The Period parameter does not contain a valid value during the first revolution after initialization, or after a change of direction.

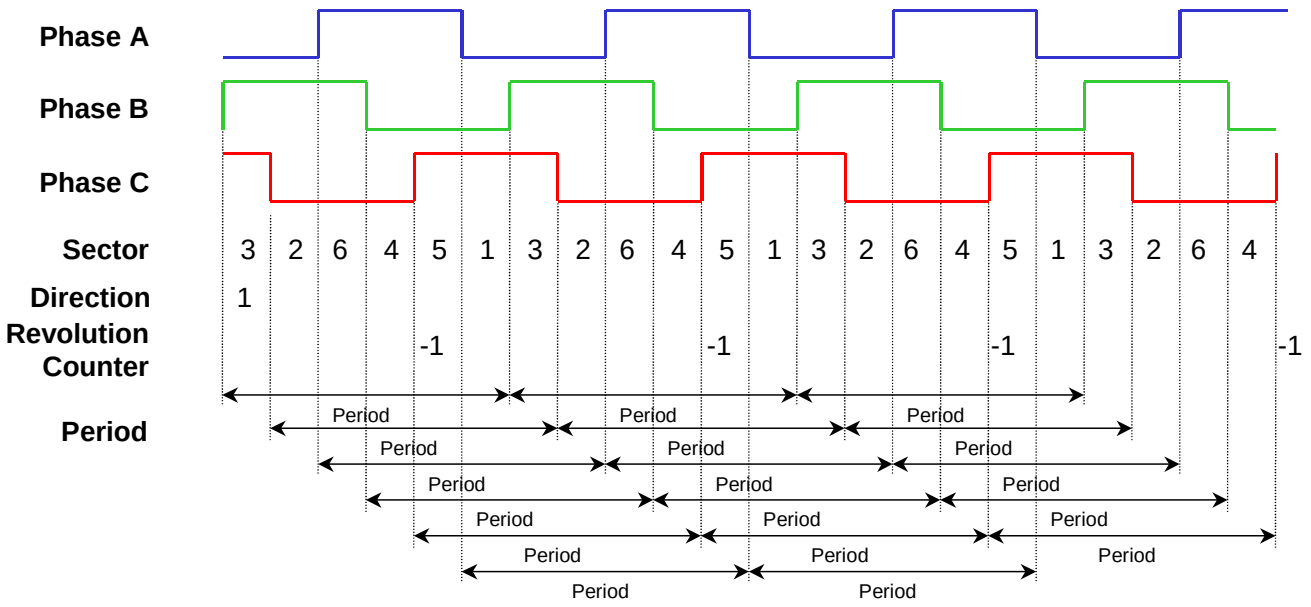

Figure 2. Hall sensor signals in opposite direction to Figure 1 and corresponding values

Two function modes are provided:

- TCR1 clock selected
- TCR2 clock selected

The selected mode is determined by the HSQ bit 1. The user has to select the same mode on all channels.

The function provides interpolation support. The parameters LastEdgeT and ActualT are updated on a Host Service Request HSR = 11. LastEdgeT then has the value of the last incoming edge time in the TCR clocks and ActualT has the current value of the TCR clock.

The CPU program should use 32-bit reads to ensure coherency of the two parameters. This applies to coherent reads of LastEdgeT and ActualT as well as the Sector and TCR_VALUE, which is necessary for interpolation calculations.

Host Interface

Written By CPU

Written by both CPU and TPU

Written By TPU

Not Used

Table 6. 3HD Control Bits

Name	Options
3 2 1 0 Channel Function Select	3HD function number (Assigned during assembly the DPTRAM code from library TPU functions)
1 0 Channel Priority	00 – Channel Disabled 01 – Low Priority 10 – Middle Priority 11 – High Priority
1 0 Host Service Bits (HSR)	00 – No Host Service Request 01 – Not used 10 – Initialization 11 – Get LastEdgeT and ActualT
1 0 Host Sequence Bits (HSQ)	x0 – Phase A or Phase B x1 – Phase C 0x – TCR1 clock selected 1x – TCR2 clock selected
0 Channel Interrupt Enable	0 – Channel Interrupt Disabled 1 – Channel Interrupt Enabled
0 Channel Interrupt Status	0 – Interrupt Not Asserted 1 – Interrupt Asserted

TPU function 3HD generates an interrupt each time the Sector is changed.

Table 7. 3HD Parameter RAM

Channel	Parameter	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Phase A	0																
	1																
	2																
	3	PinAdrPrev_A															
	4	PinAdrNext_A															
	5	PINSTATE_A															
	6	EdgeT_LH_A															
	7	EdgeT_HL_A															
Phase B	0	LastEdgeT															
	1	ActualT															
	2																
	3	PinAdrPrev_B															
	4	PinAdrNext_B															
	5	PINSTATE_B															
	6	EdgeT_LH_B															
	7	EdgeT_HL_B															
Phase C	0	Direction															
	1	RC															
	2	TCR_VALUE															
	3	Sector															
	4	Period															
	5	PINSTATE_C															
	6	EdgeT_LH_C															
	7	EdgeT_HL_C															

Table 8. 3HD parameter description

Parameter	Format	Description
Parameters written by CPU		
PinAdrPrev_A	16-bit unsigned integer	$00XA, where X is a number of Phase C channel
PinAdrNext_A	16-bit unsigned integer	$00XA, where X is a number of Phase B channel
PinAdrPrev_B	16-bit unsigned integer	$00XA, where X is a number of Phase A channel
PinAdrNext_B	16-bit unsigned integer	$00XA, where X is a number of Phase C channel
Parameters written by both TPU and CPU		
RC	16-bit signed integer	Revolution Counter value
Parameters written by TPU		
LastEdgeT	16-bit unsigned integer	TCR time of last transition *
ActualT	16-bit unsigned integer	Actual TCR time *
Direction	0 or 1	Direction 0 – Sector sequence 4, 6, 2, 3, 1, 5, 4, .. 1 – Sector sequence 4, 5, 1, 3, 2, 6, 4,...
TCR_VALUE	16-bit unsigned integer	TCR time of last transition
Sector	4, 6, 2, 3, 1 or 5	Sector: position in one of six sectors
Period	16-bit unsigned integer	Period: time of last revolution in TCR clocks.
PINSTATE_A PINSTATE_B PINSTATE_C	$0000 or $0001	The actual state of the pin is $0001 – high, $0000 – low
EdgeT_LH_A EdgeT_LH_B EdgeT_LH_C	16-bit unsigned integer	TCR time of last low-high transition
EdgeT_HL_A EdgeT_HL_B EdgeT_HL_C	16-bit unsigned integer	TCR time of last high-low transition
* The parameter values are entered by TPU on Host Service Request 11 (Get LastEdgeT and ActualT).		

Performance

Table 9. 3HD State Statistics

State	Max IMB Clock Cycles	RAM Accesses by TPU
INIT	22	5
GET_TIME	8	3
LH1	28	12
HL1	28	12
LH2	32	13
HL2	32	13

NOTE: *Execution times do not include the time slot transition time (TST = 10 or 14 IMB clocks)*

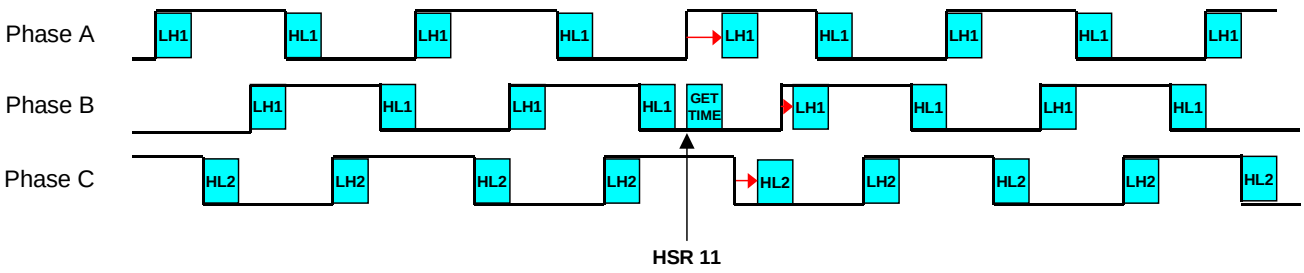

Figure 3. 3HD timing

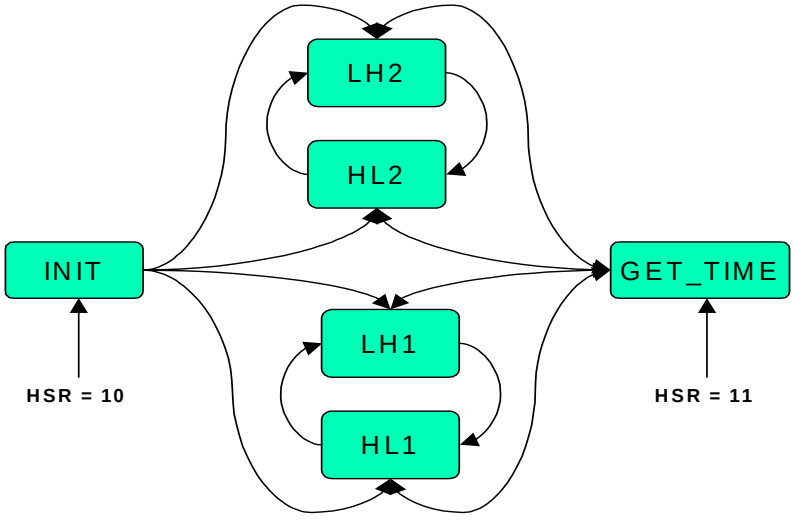

Figure 4. 3HD state diagram

Noise Immunity

The input signals can be disturbed by an impulse noise. The TPU hardware rejects short input pulses of less than a configurable number of IMB clocks. Longer pulses are processed by the TPU. Furthermore, the function itself uses a pin history to reject short error pulses that are long enough to get through the hardware filter, but not long enough to last from the actual transition time to the time that the TPU services the channel. Even longer error pulses are counted on both edges, resulting in a short-time error of the Sector value.

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