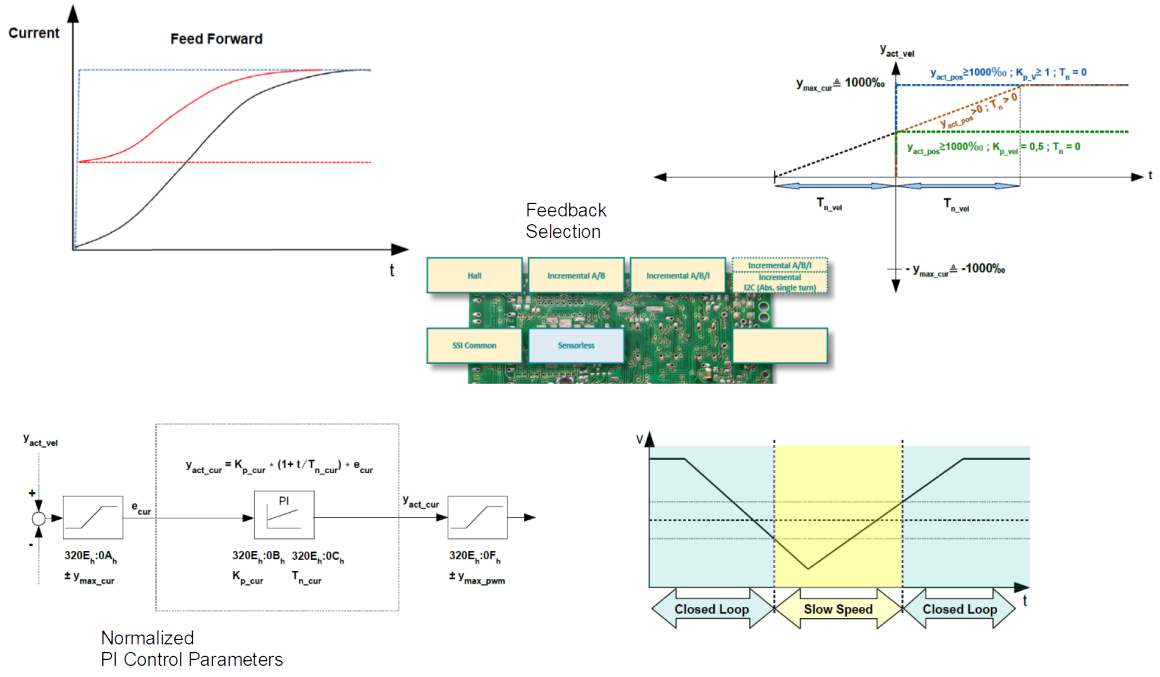
Instructions for Firmware Update

to version: FIR-v2039

For the following product groups:

C5, C5-E, N5, CL3-E, NP5, PDx-C



Normalized
PI Control Parameters

Contents

1 Introduction

To be able to better integrate new requirements, the controller firmware was revised. To use the new functionalities, you must perform a firmware update to the current version, FIR-v2039, using *Plug & Drive Studio*.

These instructions describe the differences between firmware versions FIR-1650 and FIR-v2039 and apply to the following products that are currently delivered with firmware FIR-1650:

- C5-01
- C5-E-1-09, C5-E-2-09
- CL3-E-1-0F, CL3-E-2-0F
- N5-1-1, N5-2-1
- N5-1-2, N5-2-2
- N5-1-3, N5-2-3
- N5-1-4, N5-2-4
- NP5-08
- NP5-40
- All motors of the product groups PD2-C, PD4-C and PD6-C

The instructions provide information on the modifications that must be performed so that you can use the products without difficulty in your existing applications after performing the firmware update.

Detailed documentation on the respective product and the technical manual on both firmware versions can be found on the respective product page or in the download folder of *Plug & Drive Studio* respectively, at us.nanotec.com. These instructions refer to the corresponding documents and chapters that describe in greater detail the changes/functions listed here.

1.1 Version information

Version of the instructions	Date	Changes	Old firmware version	New firmware version
1.0.0	10/2019	First edition	FIR-v1650	FIR-v1939
1.1.0	04/2020	New changes with firmware version FIR-v2013: ■ NP5: clock / direction input ■ EtherNet/IP: Change of the assembly objects New function: ■ Sync-Master Functionality New objects: $606F_h$, 6070_h, 3231_h:03_h	FIR-v1650	FIR-v2013
1.2.0	10/2020	New function: ■ Configuration of the ballast circuit New objects: 4021_h, 3250_h:09	FIR-v1650	FIR-v2039

1.2 Copyright and contact

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1.3 Emphasis in the text

The following conventions are used in the document:

Underlined text indicates cross references and hyperlinks:

- The following bits in object 6041$_h$ (statusword) have a special function:
- A list of available system calls can be found in chapter System calls in a NanoJ program.

Text set in *italics* marks named objects:

- Read the *installation manual*.
- Use the *Plug & Drive Studio* software to perform the auto setup.
- For software: You can find the corresponding information in the *Operation* tab.
- For hardware: Use the *ON/OFF* switch to switch the device on.

A text set in `Courier` marks a code section or programming command:

- The line with the `od_write(0x6040, 0x00, 5 );` command has no effect.
- The NMT message is structured as follows: `000 | 81 2A`

A text in "quotation marks" marks user input:

- Start the NanoJ program by writing object 2300$_h$, bit 0 = "1".
- If a holding torque is already needed in this state, the value "1" must be written in 3212$_h$:01$_h$.

1.4 Numerical values

Numerical values are generally specified in decimal notation. The use of hexadecimal notation is indicated by a subscript *h* at the end of the number.

The objects in the object dictionary are written with index and subindex as follows: `<Index>:<Subindex>`

Both the index as well as the subindex are specified in hexadecimal notation. If no subindex is listed, the subindex is 00$_h$.

Example: Subindex 5 of object 1003$_h$ is addressed with `1003`$_h$`:05`$_h$, subindex 00 of object 6040$_h$ with `6040`$_h$.

2 Changes

In this chapter, the main changes that you should take into consideration for the update are described. You can find a list of the changed (and of the new) objects in chapter Object overview.

2.1 N5: file system and NanoIP

Note
The N5-1-1/N5-2-1 (EtherCAT) and N5-1-2/N5-2-2 (CANopen) variants no longer have a file system. This has the following implications: ■ The stored files of the file system (`.on`) are lost after the update. You must configure the controller again. ■ The *NanoIP* web-browser-based user interface is no longer included. Use the *Plug&Drive Studio*.

2.2 Motor current setting

In FIR-v1650, object 2031_h defines the current to be used in *open-loop* and the maximum current to be used when using I^2t (motor overload protection).

In FIR-v2039, the current in *open-loop* and the maximum current when using I^2t are defined via 6073_h * 6075_h. The result of this product can be limited with 2031h.

See chapters *Setting the motor data* and *I^2t motor overload protection* in the technical manual.

2.3 User-defined units

Firmware FIR-v2039 offers you the possibility to set other user-defined units. It is thereby possible to set and read out the corresponding parameters, e.g., directly in degrees [°], millimeter [mm], etc.

A number of objects were thereby replace with new objects. See chapters *User-defined units* and *Configuring the sensors* in the technical manual.

Position unit

The factory setting for the position unit was changed and is now one “tenth of degree”. To specify one motor revolution, you would thus need to set a relative movement with “3600” as the target position instead of with “2000” as in the past.

Firmware version	Position unit (default)	Object for configuring the unit
FIR-v1650	2000 increments/revolution	$608F_h$
FIR-v2039	1°/10 (3600 per revolution)	$60A8_h$

Object $608F_h$ no longer includes a virtual encoder resolution but rather the physical resolution and mirrors a subindex from $60E8_h$ according to the position sensor set in object 3203_h. See also Support of multiple feedbacks.

Speed unit in *Velocity* mode

Without exception, the unit in FIR-v2039 is rpm . Via $604C_h$:01_h/:02_h, you can set a factor by which the speed is multiplied in order to define your own unit.

If, for example, subindex 1 is set to the value "60" and subindex 2 is set to the value "1", the speed is specified in revolutions per second (60 revolutions per 1 minute). With the factory settings in FIR-v2039, the motor speed is thus one sixtieth of the speed in FIR-v1650.

2.4 Operating mode changeover

In firmware FIR-v1650, it is not permissible to change the operating mode to the *Operation enabled* state. It is therefore possible to use 3212_h:01_h to optionally apply a holding torque in the *Switched on* state.

This behavior was revised in firmware FIR-v2039. Changeover of the operating mode can now be performed directly in the *Operation enabled* state. It is no longer necessary to switch back to the *Switched on* state nor does one need to explicitly set bit 0 in object 3212_h:01_h. If the *state machine* of *Operation enabled* is switched back to *Switched on*, the motor becomes torque-free.

Note

For the modes in which bit 4 in the controlword (6040_h) starts a travel command (e.g., *Profile Position*), the command starts immediately upon changing from *Switched on* to *Operation enabled* or upon changing the mode to the *Operation enabled* state if bit 4 was already set.

2.5 NanoJ program

- The mapping in the *NanoJ program* is checked and an error in 2302_h displayed if the entry is incorrect (e.g., wrong data type or wrong object address).
- For controllers with USB interface, the *NanoJ program* is no longer automatically started each time the controller is restarted. To start the *NanoJ program*, you must insert line `2300:00=1` in the configuration file and save the file.
- It is no longer possible to store multiple *NanoJ programs* with the N5; objects 2303_h and 2304_h are omitted.

2.6 Storing fieldbus parameters

FIR-v2039 uses new categories for separately storing/resetting fieldbus parameters such as node-ID, baud rate, IP address, etc. For this purpose there are, depending on the controller, one or more subindicies in the range $1010:08_h$ to $:0x_h$ or $1011:08_h$ to $:0x_h$.

These parameters are no longer stored/reset via 1010_h:01_h/:02 and 1011_h:01_h/02_h.

For further details, see chapter *Saving objects* in the technical manual.

2.7 Limit switch behavior

The tolerance bands that were to be set in 2056_h and permitted a movement in the zone after the limit switch no longer exist in FIR-v2039.

If a limit switch is now passed over, bit 7 (*Warning*) is immediately set in 6041_h (*statusword*) and the action that is stored in object 3701_h executed.

See chapter *Limitation of the range of motion* in the technical manual.

2.8 Controller clocking

Controller clocking has changed in FIR-v2039.

Controller	Cycle time FIR-v1650	Cycle time FIR-v2039
Current controller	31.25 µs (32 kHz)	62.5 µs (16 kHz)
Velocity controller	31.25 µs (32 kHz)	250 µs (4 kHz)
Position controller	31.25 µs (32 kHz)	1 ms

If may be necessary to modify the control parameters for *closed loop* if you continue to work with the old control parameters (object 3210_h). The new control parameters (see New controller structure) are independent of the clock signal.

Tip

If necessary, multiply the integral component of the velocity controller (3210_h:04_h) by 8 and the integral component of the current controller (3210_h:06_h/:08_h) by 2.

2.9 NP5: clock / direction input

In order to use the clock and direction input you have to activate this function in 3231_h:03_h. See chapter *Digital inputs and outputs* in the technical manual.

2.10 EtherNet/IP™: Change of the assembly objects

The Assembly Objects were changed in order to facilitate the control using Plug&Drive-Interface. See chapter *Assembly objects* in the technical manual.

3 New functions

In this chapter, the new functionalities that are available to you after an update are described. You can find a list of the new (and of the changed) objects in chapter Object overview.

3.1 Plug&Drive interface

The *Plug & Drive interface* represents a Nanotec-specific variant for controlling a drive and offers an alternative to the *device profile*, which is described in CiA 402.

With the *Plug & Drive interface*, you can immediately trigger drive commands. This eliminates the need to run through the *state machine*. The interface is supported by all controllers and Plug & Drive motors, independent of the communication interface.

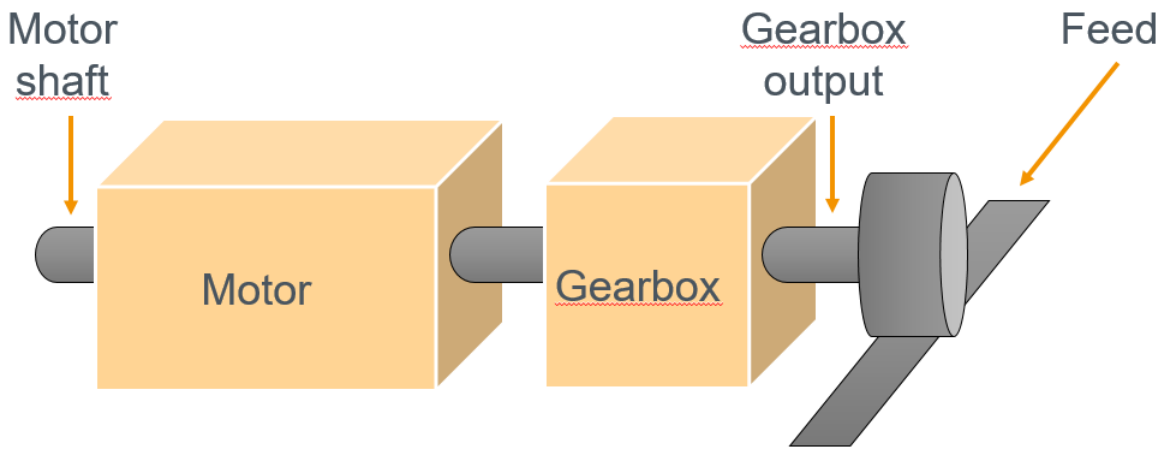
For further details, read document *Function description Plug & Drive interface*, which you can find at us.nanotec.com.

3.2 Support of multiple feedbacks

Affects the following product groups: C5-E, CL3-E, N5, NP5.

The FIR-v2039 firmware supports multiple feedbacks, which you can specifically assign to the individual control loops (current controller/commutation, speed, position). Now you can use, e.g., Hall sensors for the velocity control and for the commutation and an (external) encoder for the positioning, or the Hall sensors for the commutation immediately after switching on – until the index of the attached encoder is passed over for the first time.

You can also use sensors that are not directly attached to the motor shaft. Sensors are possible at three locations:



You can find details in chapters *Assignment of the feedbacks to the control loops* and *Configuring the sensors* of the technical manual.

3.3 New controller structure

Beginning with FIR-v1939, the new schema for the controller structure applies. This structure makes provision for standardized control parameters and the use of a feed forward. The old control parameters (object 3210_h) are still activated in the factory settings for compatibility reasons.

You can find details in chapter *Controller structure* in the technical manual.

3.4 Sensor monitoring

Affects the following product groups: C5-E, CL3-E, N5, NP5, PD2-C, PD4-C, PD6-C.

In firmware FIR-v2039, the encoder is monitored for faults. Each time the index edge is seen, a check is performed to determine whether its position is correct. If the position of the index edge exceeds the tolerance window, an error is registered and the motor stopped hard, without a ramp.

If no index is connected, this monitoring does not take place. If the index cable is interrupted during running operation, a check is no longer performed.

Monitoring also takes place with integrated absolute encoders and Hall sensors. A check is performed when switching on and during operation to determine whether they are supplying a valid position.

In case of an error, the exact error is entered in 1003_h.

3.5 Monitoring the slippage error

Affects the following product groups: C5-E, CL3-E, N5, NP5, PD2-C, PD4-C, PD6-C.

Analogous to the following error in Position Mode, the slippage error is now monitored in *Profile Velocity* mode.

If the actual speed deviates so much from the set speed that the value (absolute value) of the object $60F8_h$ is exceeded, bit 13 in object 6041_h is set. The deviation must last longer than the time in object $203F_h$.

A reaction to the slippage error can be set in object 3700_h. If a reaction is defined, an error is also entered in 1003_h.

3.6 Auto alignment

Affects the following product groups: C5-E, CL3-E, N5, NP5.

It is now possible to activate *closed loop* even if the used encoder is not equipped with an index and a second sensor is not present for the commutation.

It is now possible to have an *auto-alignment* determined once every time the controller is restarted. The previously necessary *auto setup* is also no longer necessary as a result.

You can find further details and the prerequisites for enabling the determination of the *auto alignment* in section *Activation* in chapter *Closed loop* of the technical manual.

3.7 Slow Speed

Affects the following product groups: C5-E, CL3-E, N5, NP5, PD2-C, PD4-C, PD6-C.

The new *slow speed* operating mode combines the advantages of *open-loop* and *closed loop* technologies in a low speed range and can be used if an encoder is present as feedback.

You can find details in chapter *Slow speed* in the technical manual.

3.8 Capture function

With the new object 3243_h, the current position can be noted automatically if a level change occurs at the digital input that is used for the home switch.

3.9 Configuration of the ballast circuit

With the new object 4021_h you configure the ballast circuit and can set the response threshold (for all products) and/or the parameters for its monitoring, when the ballast resistor is not part of the product (for NP5).

You can find details in chapter *External ballast circuit* in the technical manual of the NP5.

3.10 LSS protocol

Only affects products with the CANopen fieldbus.

The services of the *LSS protocol (Layer Settings Services)* are used to assign the node-ID and/or the baud rate of the controller directly via the CANopen bus. This is especially useful with devices that have no means for the mechanical configuration (e.g., rotary switches) of the parameters.

You can find further information in chapter *LSS protocol* of the technical manual of controllers with the CANopen fieldbus.

3.11 Sync-Master Functionality

Only affects products with the CANopen fieldbus.

You can activate the generating of sync messages (the controller becomes the *Sync Master* of the network), by setting bit 30 in 1005_h (COB-ID Sync) to "1". You set the cycle time in objekt 1006_h.

4 Object overview

In the course of revising the firmware, a number of new objects/functions were created and others were adapted or no longer exist. In this chapter, you will find lists with the objects of all three categories as well as a short description.

4.1 New objects

The following objects are new:

Index	Sub	Bit	Name	Description
1006_h	00_h		Communication Cycle Period	see Sync-Master Functionality
1010_h	08h – $0D_h$		Store Parameters	New subindices for separately saving fieldbus parameters such as node-ID, baud rate, IP address, etc. See Storing fieldbus parameters.
1011_h	08h – $0D_h$		Restore Default Parameters	New subindices for separately resetting fieldbus parameters such as node-ID, baud rate, IP address, etc. See Storing fieldbus parameters.
1016_h	01_h		Consumer Heartbeat Time	Only CANopen: for monitoring the Heartbeat of a producer
1019_h	00_h		Synchronous Counter Overflow Value	Only CANopen: overflow for the *Sync Counter* for Tx-PDO
1029_h	00_h		Error Behavior	Only CANopen: for defining the *NMT state* of the slave in case of an error
$180X_h$	06_h		SYNC Start Value	Only CANopen: start value of the *Sync Counter* for Tx-PDO
$1F80_h$	$00h_h$		NMT Startup	CANopen only: to set whether, after starting the controller, the state is automatically switched to the NMT state *Operational*.
$200F_h$	00_h		IEEE 802 MAC Address	Ethernet interface: the object contains the MAC address of the controller as a character string.
2010_h	00_h	5	NetBIOS Protocol Enable	Ethernet interface: for activating the *NetBIOS protocol*
2010_h	00_h	6	LLMNR Protocol Enable	Ethernet interface: for activating the *LLMNR protocol*
$203F_h$	00_h		Max Slippage Time Out	New functionality: see Monitoring the slippage error.
2290_h	00_h		PDI Control	see Plug&Drive interface
2291_h	00_h		PDI Input	see Plug&Drive interface
2292_h	00_h		PDI Output	see Plug&Drive interface
2800_h	01_h		Reboot Command	New object for rebooting the firmware
2800_h	02_h		Reboot Delay Time In ms	New object for setting a delay of the reboot.

Index	Sub	Bit	Name	Description
2800_h	03_h	0	Bootloader HW Config	For setting whether the motor windings are short circuited in boot loader mode.
3202_h	00_h	4	Open-Loop Auto-Alignment	see Auto alignment
3203_h	00_h		Feedback Selection	see Support of multiple feedbacks
3204_h	00_h		Feedback Mapping	see Support of multiple feedbacks
$320D_h$	00_h		Torque Of Inertia Factor	For setting a factor for the acceleration feed forward, see New controller structure
$320E_h$	---		Closed Loop Controller Parameter	see New controller structure
$320F_h$	---		Open Loop Controller Parameter	see New controller structure
3231_h	03_h		Alternate Function Mask	see NP5: clock / direction input
3243_h	---	---	Digital Input Homing Capture	The encoder position can be detected automatically if a level change occurs at the digital input that is used for the home switch.
3250_h	09_h			For switching the LEDs off/on.
3390_h	---		Feedback Hall	see Support of multiple feedbacks
$33A0_h$	---	---	Feedback Incremental A/B/I 1	see Support of multiple feedbacks
$33A1_h$	---	---	Feedback Incremental A/B/I 2	see Support of multiple feedbacks
$33B4_h$	---	---	SSI Encoder Multi Turn	see Support of multiple feedbacks
3701_h	00_h	---	Limit Switch Error Option Code	see Limit switch behavior
4015_h	---		Special Drive Modes	For activating the clock-direction or analog mode via (if applicable, virtual) rotary switch/DIP switch, see chapter *Special drive modes (clock-direction and analog speed)* in the corresponding technical manual
4021_h	01_h– 03_h, 01_h - 08_h resp. (for NP5)			For configurating the ballast circuit, see Configuration of the ballast circuit.
$606F_h$	00_h		Velocity Threshold	Velocity in user defined untis above which the actual velocity in mode *Profile Velocity* counts as non equal to zero.
6070_h	00_h		Velocity Threshold Time	Time in millseconds from which an actual velocity bigger than the value in $606F_h$ in mode *Profile Velocity* counts as non equal to zero.
6073_h	00_h		Max Current	see Motor current setting
6075_h	00_h		Motor Rated Current	see Motor current setting

Index	Sub	Bit	Name	Description
$607F_h$	00_h		Max Profile Velocity	Specifies the maximum speed in user-defined units for the modes *Profile Position*, *Interpolated Position* (only if closed-loop is activated), and *Profile Velocity*.
6080_h	00_h		Max Motor Speed	Replaces 2032_h
6090_h	01_h/02_h		Velocity Encoder Resolution	Mirrors a subindex from $60E6_h$/$60EB_h$ according to the speed sensor set in object 3203_h. See Support of multiple feedbacks and User-defined units.
$60B0_h$	00_h		Position Offset	Offset for the position set value in user-defined units
$60B1_h$	00_h		Velocity Offset	Offset for the speed set value in user-defined units
$60B2_h$	00_h		Torque Offset	Offset for the torque set value in tenths of a percent
$60F8_h$	00_h		Max Slippage	New functionality: see Monitoring the slippage error.
$60FA_h$	00_h		Control Effort	Contains the correction speed (control variable) in user-defined units that is fed to the velocity controller by the position controller. See New controller structure
$60FC_h$	00_h		Position Demand Internal Value	Indicates the current preset value for the position controller in increments of the sensor selected for the position in 3203_h.

4.2 Changed objects

The following objects were adapted/expanded/changed:

Index	Sub	Bit	Name	Description
2031_h	00_h		Max Motor Current	see Motor current setting
$203B_h$	01_h		Motor Rated Current	see Motor current setting
6041_h	00_h	15	FIR-v1650: Closed Loop Available FIR-v2039: Closed Loop Active	Indicates whether *closed loop* is active.
$604C_h$	---		VI Dimension Factor	see User-defined units
6063_h	00_h		Position Actual Internal Value	Use object 3203_h to set which of the existing feedbacks the controller takes into consideration for the position display.
6064_h	00_h		Position Actual Value	Use object 3203_h to set which of the existing feedbacks the

Index	Sub	Bit	Name	Description
				controller takes into consideration for the position display.
$606C_h$	00_h		Velocity Actual Value	Use object 3203_h to set which of the existing feedbacks the controller takes into consideration for the velocity display.
$608F_h$	01_h/02_h		Position Encoder Resolution	Mirrors a subindex from $60E6_h$/$60EB_h$ according to the position sensor set in object 3203_h. See Support of multiple feedbacks and User-defined units.
6091_h	01_h/02_h		Gear Ratio	Mirrors a subindex from $60E8_h$/$60ED_h$ according to the position sensor set in object 3203_h. See Support of multiple feedbacks and User-defined units.
6092_h	01_h/02_h		Feed Constant	Mirrors a subindex from $60E9_h$/$60EE_h$ according to the position sensor set in object 3203_h. See Support of multiple feedbacks and User-defined units.

4.3 Removed objects

The following objects are no longer needed:

Index	Sub	Bit	Name	Description
2032_h	00_h		Max Motor Speed	Replaced by 6080_h
2033_h	00_h		Plunger Block	Removed; this functionality can be implemented using the *NanoJ program*.
2050_h	00_h		Encoder Alignment	The *alignment* is now entered for each existing encoder in the corresponding object, in subindex 2_h, see Support of multiple feedbacks
2052_h	00_h		Encoder Resolution	The resolution is now entered for each existing encoder in the corresponding subindex in $60E6_h$/$60EB_h$, see Support of multiple feedbacks
2061_h	00_h		Velocity Numerator	Replaced by 6096_h:01_h
2062_h	00_h		Velocity Denominator	Replaced by 6096_h:02_h
2063_h	00_h		Acceleration Numerator	Replaced by 6097_h:01_h
2064_h	00_h		Acceleration Denominator	Replaced by 6097_h:02_h
2065_h	00_h		Jerk Numerator	Replaced by $60A2_h$:01_h
2066_h	00_h		Jerk Denominator	Replaced by $60A2_h$:02_h

Index	Sub	Bit	Name	Description
2303_h	00_h		Number Of Active User Program	Removed, see NanoJ program
2304_h	00_h		Table Of Available User Programs	Removed, see NanoJ program
$320A_h$	---		Motor Drive Sensor Display Open Loop	The source for the position/speed is now set in 3203_h.
$320B_h$	---		Motor Drive Sensor Display Closed Loop	The source for the position/speed is now set in 3203_h.
3212_h	01_h	0	Motor Drive Flags - Enable Legacy Power Mode	Functionality removed, see Operating mode changeover
$DD4C_h$	00_h		Special Drive Mode Config	Replaced by 4015_h, see chapter *Special drive modes (clock-direction and analog speed)* in the corresponding technical manual