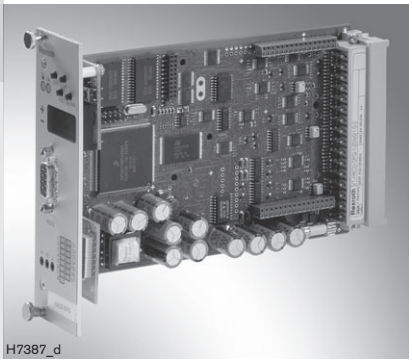
Digital Controller for electro-hydraulic Injection Molding Machines

RE 30146/08.07 1/10
Replaces: 02.06

Type VT-HACD-DPQ

Component series 2X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Features

- Actual value acquisition possible by means of SSI encoder, incremental or analogue position measuring system
- Free configuration for valve spool
- Loop tuning with ramps
- Jog mode
- Separate menus for Injection, “Pack and Hold“ and Back Pressure
- Pressure transfer by:
  - Position
  - Cavity pressure
  - Hydraulic pressure activated by position
  - Discrete input
- Enable input and OK output
- ±10 V reference voltage output
- Front display with keys for displaying and changing parameters as well as for diagnosis purposes
- RS232 serial interface
- Up to 32 control electronics for parameterization and diagnosis can be interconnected via local bus
- Internal or analogue profile
- I/O configuration

Ordering code

VT-HACD-DPQ – 1 – 2X / V0 / 1 – – 0

Digital controller card

Component series 20 to 29 **= 2X**
(20 to 29: unchanged installation and connection dimensions)

Basic unit **= V0**

1 = With display

0 = Without bus interfacing
C = CANopen
D = DeviceNet

0 = Without valve output stage

Standard types	Material number
VT-HACD-DPQ-1-2X/V0/1-0-0	R901054664
VT-HACD-DPQ-1-2X/V0/1-C-0	R901119884

Required accessories:

- PC program BODAC: Ordering code of the CD: SYS-HACD-BODAC-01 (R900777335) or free download on the Internet at www.boschrexroth.com/hacd
- Interface cable: Cable set VT-HACD-1X/03.0/ HACD-PC (R900776897) or commercial 1:1 cable
- USB adapter optionally available VT-ZKO-USB/S-1-1X/V0/0

Suitable card holders:

- 19“ rack types VT 19101, VT 19102, VT 19103 and VT 19110 (see RE 29768)
- Enclosed card holder type VT 12302 (see RE 30103) (standard), mat. no. R900784153
- Open card holder type VT 3002-2X/64G (see RE 29928), mat. no. R900991843 (for installation in control cabinet only!)
- Connection adapter VT10812-2X/64G (see RE 30105), mat. no. R900713826

Suitable power supply unit

- Compact power supply unit type VT-NE30, see RE 29929

Functional description: Overview

Overview

The VT-HACD-DPQ is a digital controller card. It optimizes the control of a hydraulic injection axis.

- Injection velocity profiles are controlled completely by use of closed loop position control. An advanced position command profile is calculated automatically based on the operator input velocity profile.
- Because the VT-HACD-DPQ is a position control device it requires a position feedback transducer. Both, analogue (0...10 V; ±10 V; 0...20 mA; 4...20 mA) and digital types (SSI, INCR) are supported by the VT-HACD-DPQ.
- The VT-HACD-DPQ includes injection force-limiting control that can be configured to work with 1 or 2 pressure transducers or a load cell.
- The injection velocity and pressure profiles may be controlled with one proportional directional hydraulic valve or separate valves for flow and pressure.
- Motion profile command values are normally transferred into the VT-HACD-DPQ from a PLC (analogue). The profiles may also be entered into the card using the Bosch Rexroth BODAC software.

Function

The VT-HACD-DPQ is a complete hydraulic injection axis control solution. An injection profile is created from parameters that are entered by the machine operator. All injection cylinder process parameters are then stored on the card. Parameter changes may be individually loaded into the VT-HACD-DPQ, or the entire profile loaded at one time. The VT-HACD-DPQ maintains the last saved profile in a non-volatile flash memory. A single injection profile is stored on the card. A discrete input (enable) is required to enable the VT-HACD-DPQ .

Functional description: Injection control

Mould fill profile

A velocity profile of up to ten steps is provided to fill the mould cavity.

A maximum pressure/force limit may be set for each profile step. The injection cylinder is traversed under closed loop control on the basis of the velocity profile (closed-loop position control).

At the start of inject forward the internal position command value is set equal to the current cylinder position feedback and then ramped forward at a rate of movement corresponding to the velocity command in the current profile step. The steps are followed in subsequent order. Each step in the profile is initiated when the internal position command value has been reached. Repeatability of the profile is determined by adjusting the proportional gain as high as possible so the injection cylinder closely follows the internal position command value under varying load conditions. This type of system is used because it is relatively unaffected by changes in plastic material properties or temperature. Because the position control loop is a ramp of position command value over time, the change of velocity between the profile steps is seamless and does not require any extra ramp adjustments.

Transfer to Hold Pressure

The VT-HACD-DPQ begins the “hold pressure” profile when any of the predetermined transfer criteria are achieved. Transfer criteria available in the stored profile are hydraulic pressure, cylinder position, and mould cavity pressure or digital input 3 (DI3). All of the transfer criteria are continuously monitored, so any criteria not used must be set to a value that will not be reached during the mould fill velocity profile. The hydraulic pressure command value is enabled only if the injection cylinder position is less than the hydraulic transfer position parameter.

This allows the initial acceleration pressure to be higher than the transfer pressure without triggering the hold pressure profile. The machine control may also initiate the transfer on the basis of a digital input (DI3).

The completion of the process is signalled to the machine control via digital input DO1.

Hold Pressure Profile

A pressure profile up to five steps long is available for pack and hold. Once the hold profile is initiated, the VT-HACD-DPQ changes mode into closed-loop pressure/force control with superimposed open loop velocity control. Any remaining steps in the velocity profile are ignored. In each step the pack and hold profile, pressure (force), time, and velocity limit can be adjusted.

Step 1 in the profile is started at the time of transfer. Each subsequent step in the pack and hold profile is initiated when the previous step timer is finished.

The velocity limit in step 1 of the pack and hold profile is typically used to prevent the injection cylinder from lunging forward to build up pressure/force when transfer by position is used. This also allows the DPQ to react faster when transfer by hydraulic mould cavity pressure is initiated, by closing down the flow control valve to a smaller opening within 2 msec of transfer, preventing pressure/force overshoots. The velocity limit in the subsequent pack and hold profile steps is typically set higher so it does not limit the dynamic response of the pressure/force control loop.

Pre-Decompress

After the last timer is completed in the hold pressure profile, the VT-HACD-DPQ automatically decompresses the screw. Pre-decompress is active if the pre-decompress position parameter is greater than the actual injection cylinder position at the end of the pressure hold profile. The pre-decompress velocity parameter is an open loop valve command. Pre-decompression is complete once the injection cylinder position is equal to or greater than the pre-decompress position parameter. At the end of pre-decompression the VT-HACD-DPQ raises a signal to the machine control that decompress is complete. The valve outputs are set to 0V at the end of pre-decompression.

Back pressure

To begin recovery the machine control raises the recovery discrete input DI. The VT-HACD-DPQ then controls the injection unit recovery based on the position, velocity, and pressure parameters in a 3-step recovery profile.

Back pressure is closed-loop controlled with an open loop velocity limit. The next step in the recovery profile is triggered by the increasing injection cylinder position as recovery continues. When applied to a single injection valve hydraulic circuit the velocity parameter for each back pressure step is set as a forward valve opening limit. When applied to a hydraulic circuit which uses a separate back pressure proportional relief valve the velocity parameter can be set to whatever valve command is necessary for the injection directional proportional valve, for example screw motor speed on some hydraulic systems.

Screw recovery mode is complete when the injection cylinder position is equal to or greater than the shot size parameter. The VT-HACD-DPQ signals to the machine control when shot size is reached. Back pressure control will be maintained until post decompress begins.

Post Decompress

When the post decompress discrete input (DI6) is raised by the machine control, the post decompress mode is started, if the injection cylinder position is equal to or greater than the shot size. The post decompress velocity parameter is an open loop valve command.

Post decompression is complete when the injection cylinder position is equal to or greater than the post decompress position parameter. When the post decompress position is reached, the VT-HACD-DPQ sets the valve outputs to 0V and signals this to the machine control.

Functional description: Injection control (continued)

Injection configuration options

The VT-HACD-DPQ can be applied in one of two injection configurations that depend on the hydraulic system.

1. Preferred configuration: closed-loop velocity profile and pressure control using one proportional injection valve and one analogue valve output. This type of system will control the injection velocity profile, pressure profile, back pressure, and screw decompress using a single proportional directional valve. The available dynamic response with this type of system is much better than with systems that use separate valves for flow and pressure control, which means that closed loop tuning can be adjusted for faster and more precise control.
2. Closed-loop velocity profile, and either closed or open-loop pressure control using one proportional directional or flow control valve for the velocity profile and one proportional pressure control valve for injection pressure control. There are two analogue valve outputs available for this configuration. This configuration does not require as high dynamic response from the proportional flow control valve as the single valve configuration. Overall system control will not be as dynamic or repeatable due to limitations of separating flow and pressure functions into multiple valves, and inherent dynamic limitations of proportional pressure control valves.

Additionally, the VT-HACD-DPQ may be configured so that the second valve output is controlled directly by a machine control instead of the internal pressure profile.

Applications

The VT-HACD-DPQ is configured to control injection moulding type applications, and all parameters are labelled to be recognizable in injection moulding applications. There are, however, many other applications that could benefit from the control quality afforded by the VT-HACD-DPQ.

– Transfer moulding
– Extrusion
– Broaching
– Rubber moulding
– Accumulator head blow moulding

Front panel operation

The front display is used in conjunction with the 4 push-buttons to display and change operator parameters.

Access is given to the following operator parameters:

– Mould fill profile
– Transfer parameters
– Hold pressure profile
– Recovery profile
– Decompress parameters

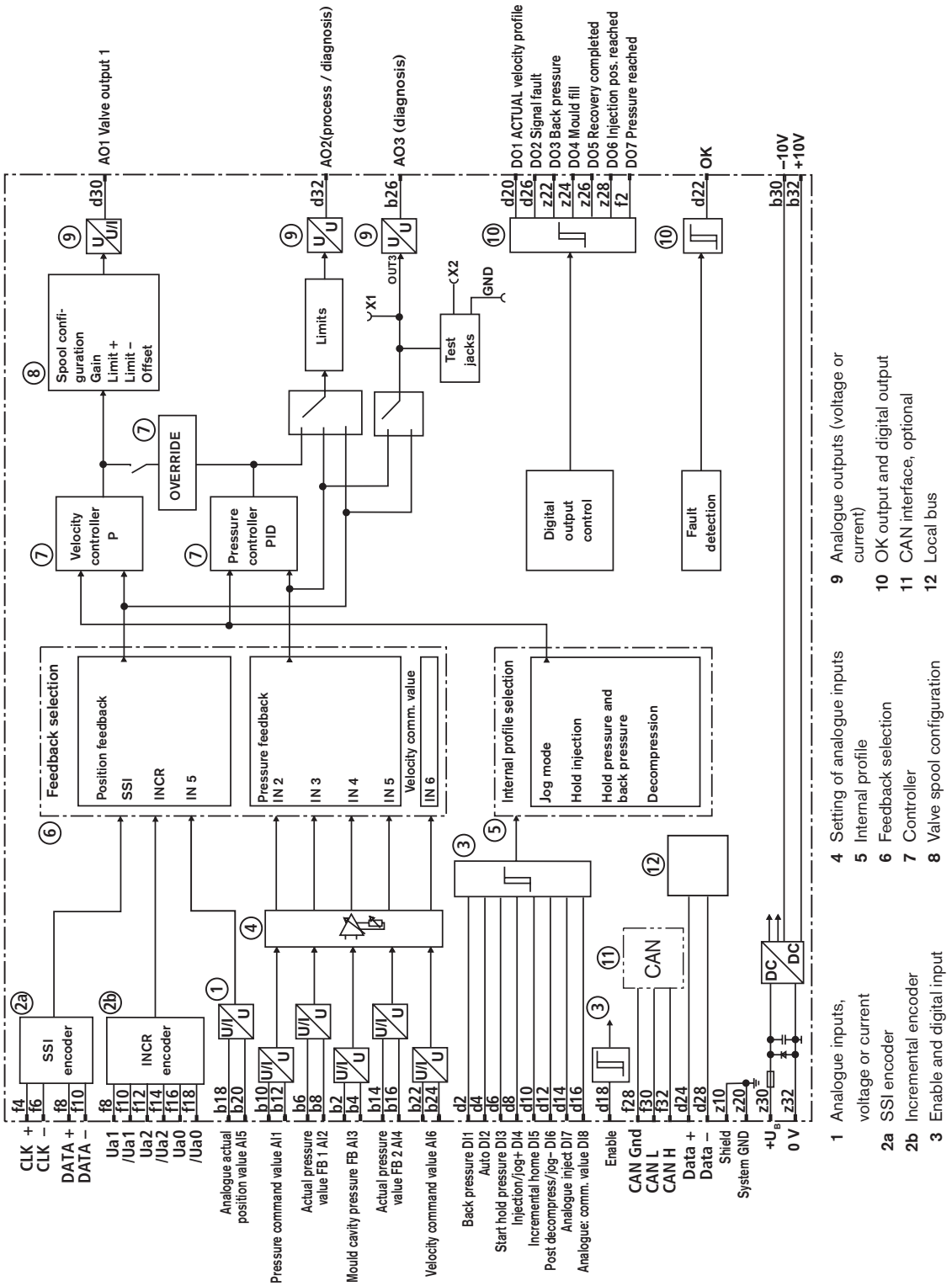
For safety reasons, set-up and configuration parameters are not accessible through the front panel.

Fault messages will be displayed when a fault occurs.

PC program BODAC

The PC program BODAC is used for the configuration, parameterisation and diagnosis of the VT-HACD-DPQ via a serial interface (RS 232). Up to 32 control electronics can be interconnected via the local bus. Each control electronics is assigned a bus address by means of BODAC. Re-plugging of the serial interface cable is not required. For further information, see RE 30146-01-B.

Block circuit diagram



Technical data (for applications outside these parameters, please consult us!)

Operating voltage	U_O	24 VDC
Operating range:		
– Upper limit value	$u_O(t)_{max}$	35 V
– Lower limit value	$u_O(t)_{min}$	21 V
Current consumption	I_{max}	150 mA
Fuse	I_S	4 A slow-blowing
Digital inputs	Signal	log 0 = 0 to 5 V
		log 1 = 16 V to U_O
Digital outputs	Signal	log 0 = 0 to 5 V
		log 1 = 16 V to U_O
		I_{max} = 30 mA
Analogue inputs AI1…AI6		
Configuration as voltage input		
Range	U	0 to 10 V or ±10 V (configurable)
Input resistance	R_i	100 kΩ, > 10 MΩ for input AI 1
Resolution		5 mV for range ±10 V, 2.5 mV for range 0...10 V
Non-linearity		< 10 mV
Configuration as current input		
Range	I	0...20 mA or 4...20 mA (configurable)
Input resistance	R_i	100 Ω
Current loss		0.15 % (at 500 Ω between pin AI x– and 0 V)
Resolution	I	5 µA
Analogue outputs		
AO1 configuration as voltage output		
Output voltage	U	0...10 V or ±10 V (configurable)
Output current	I_{max}	10 mA
Load	R_{Lmin}	1 kΩ
Resolution		1.25 mV (14 bit)
Residual ripple content		±15 mV (without noise)
AO1 configuration as current output		
Output current	U	0...20 mA or 4...20 mA (configurable)
Load	R_{max}	500 Ω
Resolution		1.25 µA
Residual ripple content		±15 µA (without noise)
AO2 / AO3		
Output voltage	U	±10 V
Output current	I_{max}	10 mA
Load	R_{Lmin}	1 kΩ
Resolution		10 mV (11 bit)
Residual ripple content		±25 mV (without noise)
Reference voltage	U	±10 V
	I_{max}	30 mA
Residual ripple content		< 20 mV
Scanning rate	t	2 ms
Serial interface		RS232 (front panel), D-Sub socket
Type of connection		64-pin male connector, DIN 41612, form G
Local bus, distance to the farthest station	l	Max. 280 m cable length

Technical data (continued)

Card dimensions		Euro-card 100 x 160 mm, DIN 41494
Front panel dimensions: – Height – Width soldering side – Width component side		 3 HE (128.4 mm) 1 TE (5.08 mm) 7 TE
Permissible operating temperature range	ϑ	0 to 50 °C
Storage temperature range	ϑ	–20 to +70 °C
Weight	m	0.2 kg

Pin assignment of male connector

PIN	Row z	Row b	Row d	Row f
2	n.c.	AI3+: Cavity pressure [1]	DI1: Back pressure	DO7: Pressure
4	n.c.	AI3–: Cavity pressure [1]	DI2: Auto	SSI clock+
6	n.c.	AI2+: Pressure FB 1 [1]	DI3: Start hold pressure	SSI clock–
8	n.c.	AI2–: Pressure FB 1 [1]	DI4: Injection/jog+	SSI data+; Inc. Ua1
10	n.c.	AI1+: Pressure command [1] [3]	DI5: Incremental Home	SSI data–; Inc. /Ua1
12	Shield	AI1–: Pressure command [1] [3]	DI6: Post Decomp./jog–	Inc. Ua2
14	n.c.	AI4+: Act. pressure FB 2 [1]	DI7: Analogue injection	/Inc. Ua2
16	n.c.	AI4–: Act. pressure FB 2 [1]	DI8: Analogue comm. value	Inc. Ua0
18	n.c.	AI5+: Analogue cyl. position [1]	Enable	/Inc. Ua0
20	System ground	AI5–: Analogue cyl. position [1]	DO1: Actual velocity profile	n.c.
22	DO3: Back Presuure	AI6+: Velocity command [1]	Card OK.	n.c.
24	DO4: Inject Forward	AI6–: Velocity command [1]	Data+: Local bus	n.c.
26	DO5: Decom. Achieved	AO3: Valve output	DO2: Signal fault	n.c.
28	DO6: At Shot Size	Analogue GND	Data–: Local bus	CAN Gnd
30	UB: +24 V	–10 V	AO1: Valve output 1 [2]	CAN L
32	LO: 0 V	10 V	AO2: Valve output 2	CAN H

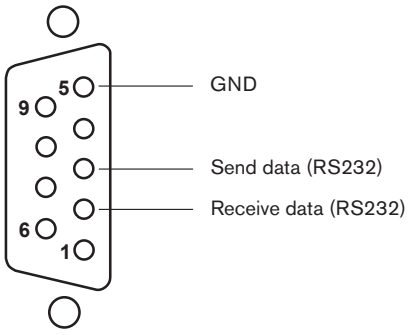
[1] The inputs can be set to 0...10 V, ±10 V or 4...20 mA by means of software.

[2] Output AO 1 can be set to 0...10 V, ±10 V or 4...20 mA by means of software.

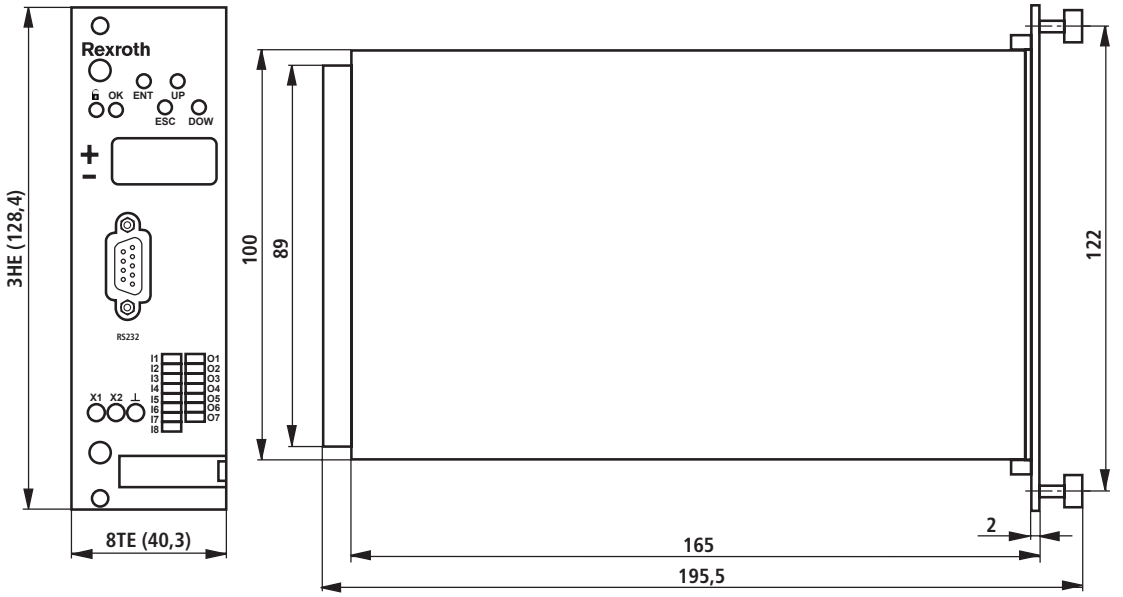
[3] This input has an input resistance of $R_i > 10$ MΩ

n.c. ... not assigned in the basic version, but reserved for extensions.

Pin assignment of D-sub socket on the front panel



Unit dimensions (dimensions in mm)



Engineering / maintenance notes / supplementary information

Product documentation for VT-HACD-DPQ

- RE 30146
  Technical data sheet (this document)
- RE 30146-B
  Installation and operating instructions
- RE 30146-01-B
  Commissioning and operating instructions
- RE 30146-U
  Declaration on environmental compatibility
- RE 30146-02-Z
  Start-up CANopen Interface
- RE 30146-03-Z
  Start-up DeviceNet Interface

– Use low-capacitance cables. Whenever possible, establish cable connections without intermediate terminals.
– The arrangement of electromagnetic sources of interference (e.g. frequency converter) in the direct vicinity of the closed-loop control electronics is not permitted.
– Do not lay power cables in the direct vicinity of the controller card.
– Do not lay cables of the control electronics in the direct vicinity of power cables.
– Lay sensor cables separately.
– The distance to aerial lines, radio sources and radar equipment must be at least 1 metre.
– Engineer the system so that when the differential inputs are used, both inputs are always activated or deactivated simultaneously.
– Use relays with gold-plated contacts for passing on command values (small voltages, small currents).
– Always shield command value and actual value cables. Connect the shield to “shield“ on the card side and leave the other end open, otherwise, there is a risk of earth loops.
– Use highly flexible CU conductors (min 2.5 mm^2) for connecting the system ground! The system ground is an essential part of EMC protection of the controller card. It discharges interference that is transported via data and supply voltage cables to the controller card. This function can only be ensured, if the system ground itself does not inject interference into the controller card. Rexroth recommends that solenoid cables be shielded as well.
– Electrical signals brought out via control electronics (e.g. the “OK“ signal) must not be used for switching safety-relevant machine functions!
(See also European Standard “Safety requirements for fluid power systems and components - hydraulics“ EN982:1996)

Notes

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