

Revision History

Table of Revisions

Date	Page	Changed	Rev
March 2010	—	First edition	AA

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Front cover illustrations: F301602, F500018, F101425, F101919, F101920

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About this document

This document provides general information about the Integrated Automotive Control System. In addition, it is a reference tool for vehicle OEM design, engineering, and service personnel.

For easy access by control system developers, this document along with relevant software files, user manuals, and other documents is included in the application file posted on line at www.sauer-danfoss.com

This document is one of several sources of technical information for the control system. Other sources of technical information include the referenced documentation listed below.

Referenced Documentation

Referenced documents are on line at: www.sauer-danfoss.com
(enter provided Sauer-Danfoss order numbers in search feature on web site).

Hydraulic Products

H1 Pump with Integrated Automotive Control Document Order Numbers

Description	Data Sheet number	Technical Information number	User Manual number
H1P045/053	11063904	11063344	
H1P060/068	TBA	TBA	
H1P078	11038154	11068353	
H1P089/100	11071391	11071849	
H1P115/130	11063906	11071850	
H1 AC Embedded Controller			70012797

H1B Motor Document Order Numbers

Description	Data Sheet number	Technical Information number
H1B080	11055986	
H1B110	11042714	
H1B Motors		11037153

Electronic Products

Document Order Numbers

Description	Technical Information number
H1 Automotive Control Product Electrical Installation	11063344
H1 Speed and Temperature Sensor	11046759
KEP Electronic Foot Pedal	11044978
JS1000 Joystick	520L0826
JS6000 Joystick	520L0760
DP200 Graphical Display	11023625
DP600 Graphical Display	520L0699

Software Products

Document Order Numbers

Description	Technical Information number	User Manual number
PLUS+1 Service Tool		520L0899
Recommended System Start-up Procedures	11010667	

OEM Responsibility

The manufacturer of a machine or vehicle using PLUS+1™ electronic controls is responsible for correctly applying and configuring PLUS+1 products. Sauer-Danfoss strongly recommends that the OEM perform a system-level Failure Mode Effects Analysis (FMEA).

You can find additional information about OEM responsibilities in the *PLUS+1 Controller Family Technical Information, 520L0719* and *Recommended System Start-up Procedures Technical Information, 11010667*.

Concept and Function

The Sauer-Danfoss H1 Automotive Control (H1 AC) system is designed to provide a “drive like your car” seamless, shift free, variable automatic transmission for off-highway propel drive systems. An electronic controller integral to the H1 pump combines enhanced control performance with a flexible, configurable control scheme for an entire single path propel transmission. The controller converts either direct operator input or an engine speed signal into an automotive drive signal to control the displacement of an axial piston pump. It is also designed to control motor displacement via an electric two position or electric proportional control valve, as well as manage other inputs and outputs related to the vehicle propel transmission. With easily changeable control parameters, it is possible to tailor the vehicle driving behavior to the individual requirements of the machine.

The H1 AC is integrated with the NFPE (Non-Feedback Proportional Electric) Control. The flexible system configuration allows use of a wide range of foot pedal, joystick, and motor combinations out of the Sauer-Danfoss product portfolio.

The H1 AC has also been certified by TÜV Nord to SIL 2 level functional safety standard according to IEC 61508 standard. With a pre-certified propel transmission it will reduce OEM time and expense to achieve vehicle certification according to Machinery Directive 2006/42/EC applicable to all vehicles produced in or sold into the European Community after 29 December 2009.

The combination of state of the art technology of embedded digital electronic control and Sauer-Danfoss proven axial piston pump technology opens a wide range of application possibilities.

AC-1 System Option Portfolio

Any combination of packages A + (B, C, and/or G) is available. For package combinations specific to your needs consult your Sauer-Danfoss representative.

Feature type	Function description	Functional Option Packages (FOPs)					
		FOP A	FOP B	FOP C	FOP F	FOP G	FOP H
		Basic	Motor Speed Sensor	CAN J1939	Full without SIL	SIL-2 Certified System	Full with SIL
Functional features	Forward-Neutral-Reverse directional control (F-N-R)	●	●	●	●	●	●
	Inching	●	●	●	●	●	●
	Motor control	●	●	●	●	●	●
	Engine RPM signal	●	●	●	●	●	●
	Selectable System Modes	●	●	●	●	●	●
	Creep mode	●	●	●	●	●	●
	Temperature compensation	●	●	●	●	●	●
	Engine overspeed protection	●	●	●	●	●	●
	Pump hysteresis compensation	●	●	●	●	●	●
	Park brake torque test	●	●	●	●	●	●
	Forward & Reverse LED output	●	●	●	●	●	●
	Anti-stall	○	●	○	●	○	●
	Brake Pressure Defeat (BPD)	○	●	○	●	○	●
	Closed loop Constant Speed Drive (CSD)		●		●		●
	Maximum torque at vehicle start		●		●		●
	Hydraulic motor over-speed protection		●		●		●
	Engine data via CAN			●	●		●
	H1 AC subsystem data via CAN			●	●		●
Engine speed control shared with external controller			●	●		●	
Safety features	Hydraulic system overheat and low temperature protection	●	●	●	●	●	●
	Operator presence detection	●	●	●	●	●	●
	Brake light output	●	●	●	●	●	●
	Vehicle speed triggered digital output signal	●	●	●	●	●	●
	Safety controlled start	●	●	●	●	●	●
	Fault LED output	●	●	●	●	●	●
	Parking brake control	●	●	●	●	●	●
	Reverse buzzer output	●	●	●	●	●	●
	SIL-2 certified hardware	●	●	●	●	●	●
	Vehicle speed limitation		●		●	●	●
	SIL-2 certification for propel system (Hardware and Software) per IEC 61508					●	●
Economic and convenience features	Easy to use electronic inching calibration (no extra valving or mechanical adjustments)	●	●	●	●	●	●
	Semi-automatic sensor calibration (i.e. foot pedals)	●	●	●	●	●	●

AC-2 System Option Portfolio

AC-2 system, available with all AC-1 functional option packages, provides enhanced pump control and system functionality with the addition of a pump swash angle sensor and related software.

Functional features		FOP A	FOP B	FOP C	FOP F	FOP G	FOP H
Load independent pump displacement control		●	●	●	●	●	●
Breakaway motor torque override		●	●	●	●	●	●

Key: ○ Basic functionality ● Full functionality

Benefits

The new Automotive Control (AC) option for H1 pumps puts 40 years of mobile machinery propel system experience at your fingertips: through software configuration it enables faster time-to-market and improved performance and functionality for both new machine designs and model variants.

Sauer-Danfoss offers years of application expertise in a fully integrated, pre-tested Automotive Control System solution that's ready to be tailored to your vehicle requirements. The integrated automotive control system is a complete vehicle transmission solution offering benefits including:

- Reduced OEM time-to-market for new vehicles and model variants
- Reduced system development, vehicle qualification, and certification expense
 - State-of-the-art system level functional safety design certified to SIL 2 per IEC 61508 standard
- Enhanced, flexible functionality through embedded intelligent electronics

Driving Profiles

- Four selectable system modes, selectable via switches
- Independent curves and settings for forward and reverse (4 x 2 curves)
- Switch selectable between automotive and engine speed independent driving modes
- Engine speed independent drive modes for sweepers, snow blowers (non-automotive mode)
- Load independent drive modes for off road applications (non-automotive for rollers and forestry machines)
- Load independent swash-plate control via pump swash-plate angle sensor to achieve EDC-like behavior
- Creep speed mode (for example: slow shunting, digging operation, etc)
- Constant speed mode (for example: sweepers, snow-blowers, etc)
- Integrated vehicle speed limiter function

Advanced Control Functions

- Inch function without separate control valve
- Integrated temperature sensor for:
 - Hydraulic system overheat protection
 - Low temperature pump flow limitation
 - Compensation of oil viscosity changes
- Configurable engine antistall protection
- Engine overspeed protection while inching

Integrated Motor Controller

- Integrated hydraulic motor control for:
 - Proportional, variable PCOR or two position motor controls
 - Brake pressure defeat, depending on the FNR position or the actual vehicle driving direction
 - Initial breakaway motor torque override
- Separate overspeed protection for the hydrostatic motor

Auxiliary Functions

- Four auxiliary digital outputs for :
 - Intelligent brake light control
 - Automatic park brake function
 - Vehicle speed dependent output to activate (load stabilizer, warning lights, etc)
 - Reverse buzzer controlled by FNR or reverse driving
 - System status lamp (fault detection for pump solenoids)

Economic Features

- Technology enabler for economic driving and fuel savings
- Easy combination options to other components of the PLUS+1 Family

CAN Options

- Engine remote control via CAN J1939
- Integrated signal converter (analog driving pedal into CAN signal, etc)
- Compatible to all CAN J1939 components on market (displays, etc)

Functional Safety

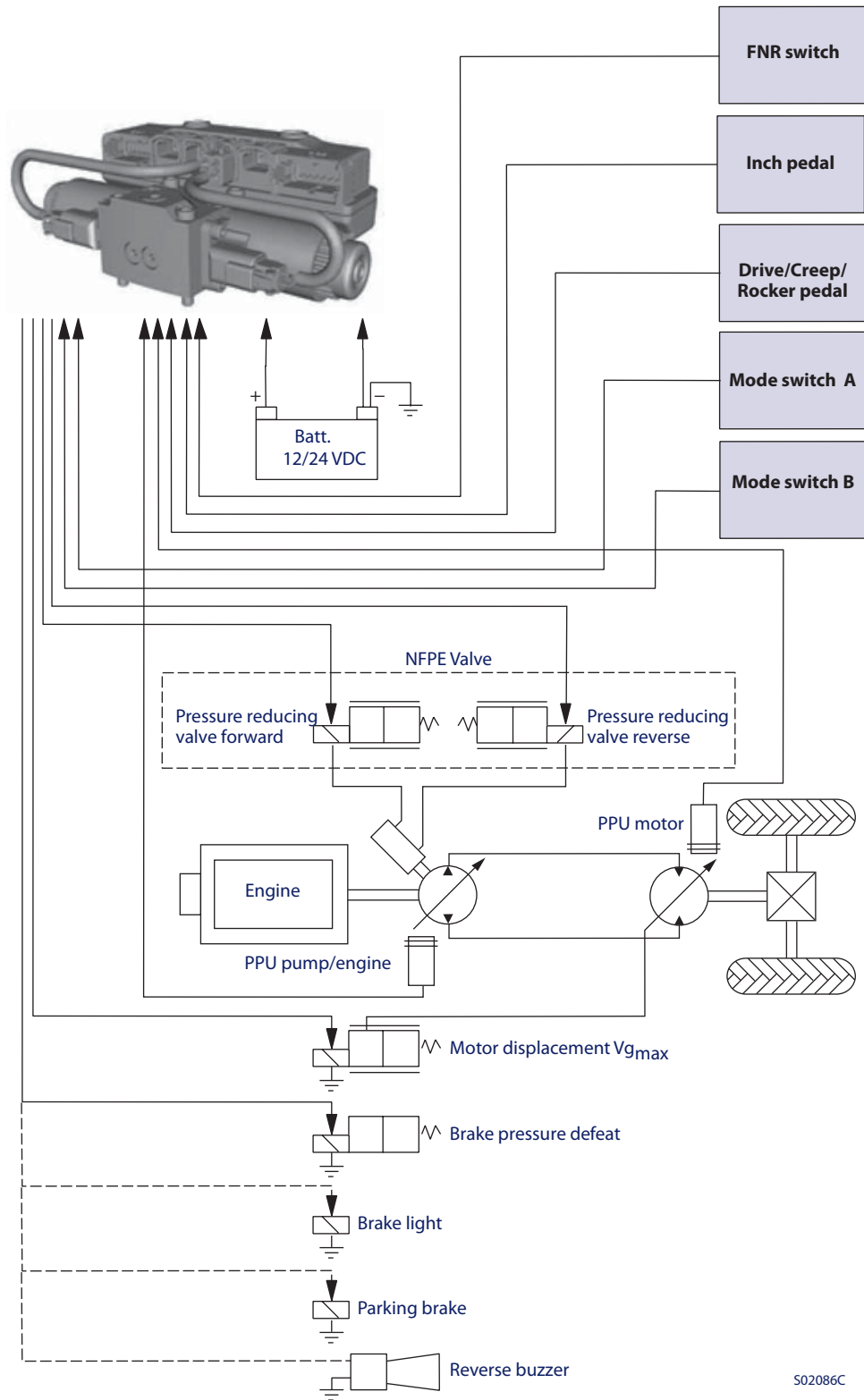
Sauer-Danfoss strongly recommends that the OEM perform a system-level Failure Mode Effects Analysis (FMEA)

- External Safety Certification for SIL-2 per IEC 61508 standard (see also appropriate H1 AC pump Technical Information brochure specified in section 1.2.1 for minimum system hardware, vehicle wiring, and software parameter setting requirements to meet SIL 2 certification standard)
- Safety controlled Vehicle Start-Protection (engine speed check, battery check and FNR must be in neutral, etc)
- Operator presence detection
- Vehicle speed dependent direction change lock
- Brake test mode for road roller (compactor) vehicle applications to fulfill EN500-4

Installation Features

- Factory calibration for hysteresis compensation

System Overview



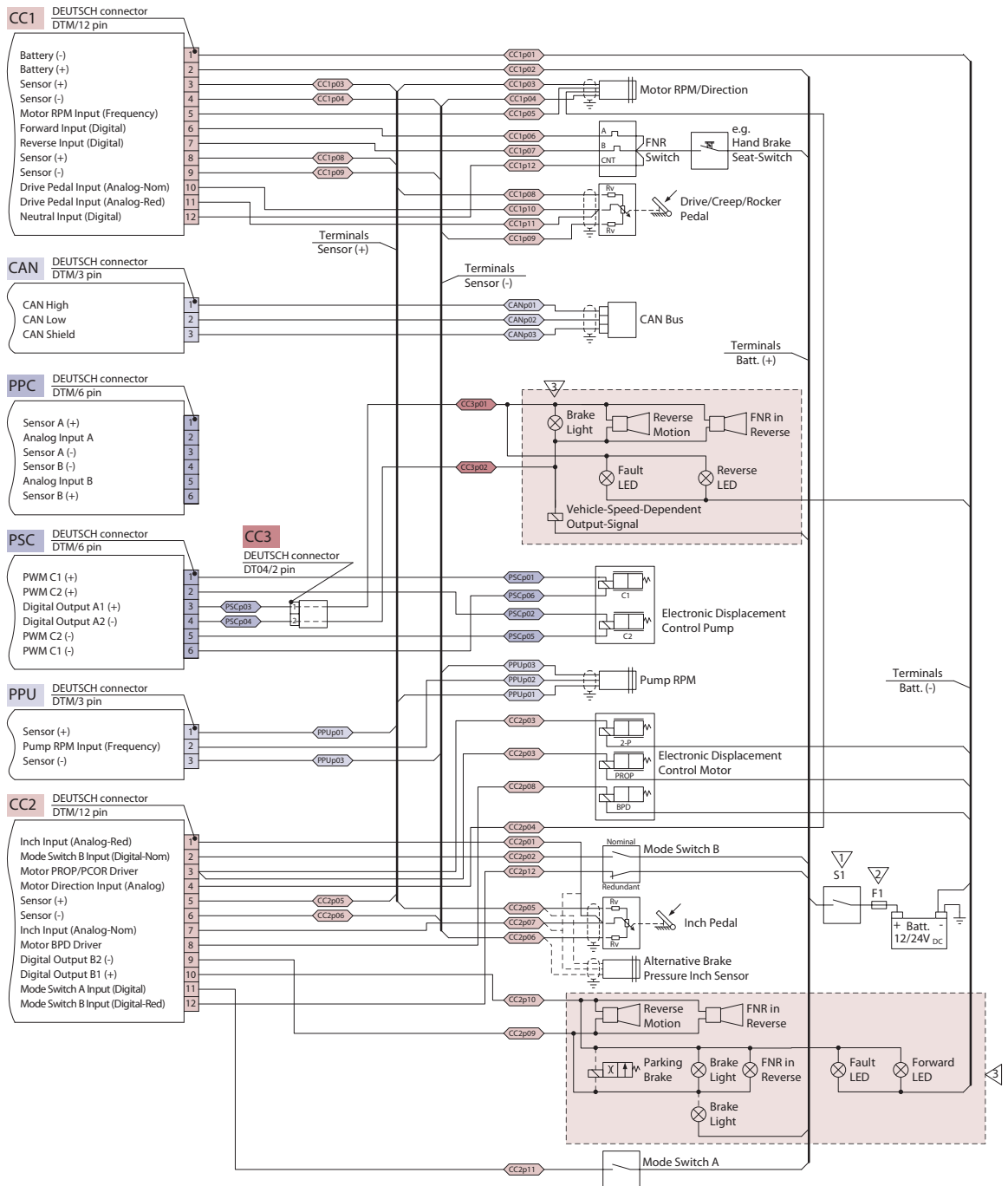
S02086C

Swashplate sensor included (option). Temperature sensor on board.

Wiring Diagram

Generic Wiring and Component Interconnections

- Contact capability min. 10A
- Melting fuse 16A
- Functional options



P108 109E

Swashplate sensor included (option). Temperature sensor on board.

**System Controller
Details****Inputs**

- FNR switch and driver presence detection
 - The FNR switch, used to communicate driving direction, requires two or three digital inputs. The detection logic is configurable. The neutral input can be used also as well as an enable signal (seat-switch, driver presence detection, etc).
- Mode switch A and B
 - Mode switch A and B are used to select one of four different system modes. Mode switch B features a redundant input for safety purposes.
- Inch pedal/sensor
 - The inch pedal/sensor is an analog input which ultimately reduces the current to the pump and motor control valves. This input allows the operator to keep vehicle propel speed low while raising the engine speed to meet the flow demands for the auxiliary functions.
- Drive/creep or rocker pedal sensor
 - The drive/creep or rocker pedal sensor is an analog input typically consisting of a potentiometer, joystick, or rocker pedal, all software configurable. The input is used in creep automotive mode as the source for the creeping setpoint and in the non-automotive mode as the speed or flow setpoint.
- Pump/engine speed sensor
 - The pump/engine speed sensor, pre-assembled and pre-wired at the factory level, measures pump/engine speed. The sensor uses Hall Effect technology to detect the rotating speed ring.
- Integrated temperature sensor
 - The integrated temperature sensor measures PCB board temperature, proportional to oil temperature, to enable temperature compensation and temperature derate functions.
- Hydrostatic motor speed sensor (optional)
 - The hydrostatic motor speed sensor, normally installed directly on the hydrostatic motor, measures motor RPM. When the sensor is installed in a gear box, the software parameter can be used to define the gear ratio. An additional analog input can be used to detect rotational direction.
- Integrated pump swash-plate sensor (optional)
 - The integrated pump swash plate sensor (option AC2) detects actual swash plate position and is embedded in the pump control. The swash plate position can be passively monitored or actively controlled to enable an effective flow control and load independent propel behavior.

**System Controller
Details
(continued)****Outputs**

- Proportional pump control
 - The proportional pump control directly drives current to the pump proportional control valves. The proportional valves are pre-assembled and pre-wired to the integrated automotive control at the factory level. Start and end stroke current as well as hysteresis settings based on pre-calibrated start RPM are configured during end of line testing. Wire fault and over current detection are integrated control functions.
- Two position / proportional motor control
 - The two position/proportional motor control provides an output to control an electric two position or proportional motor control valve in order to control motor displacement. Wire fault and over current detection are integrated control functions.
- Brake pressure defeat
 - The brake pressure defeat is a digital output for an electrical brake pressure defeat valve of a motor control. The output directly links the brake pressure control to the vehicle propel direction and timing to prevent abrupt deceleration. During deceleration events the brake pressure signal is prevented from activating the pressure compensator inside the motor control (PCOR). The motor maintains minimum displacement (minimum braking torque) and is prevented from shifting to maximum displacement.
- Park brake control
 - The integrated automotive control provides four digital outputs that can be used to control park brake activation under conditions such as:
 - Software machine state in STOP mode
 - Actual pump valve current below user defined value
 - Actual inch pedal command exceeds user defined value
 - Delay times for park brake application and release are individually configurable
- Brake light control
 - The brake light output digitally drives an indicator lamp (within the specified hardware output limits) when the inch pedal command exceeds a user defined value.
- Buzzer control
 - The reverse driving direction buzzer output controls a buzzer that indicates reverse driving direction. The output logic can be directly controlled by FNR status or by actual propel movement.

**System Controller
Details
(continued)**

Outputs (continued)

- Forward and reverse direction LED output
 - The forward and reverse direction LED output function digitally drives LEDs as driving direction indicators for use in dashboard/display and is directly linked to the FNR status.
- Status output (red LED)
 - The fault status output provides an output signal of the internal fault status/error code capable of digitally driving an LED.
- Vehicle speed dependent output
 - The vehicle speed dependent output signal toggles a digital output when the actual vehicle speed exceeds a user defined speed.

Automotive Mode

In automotive mode the drive curve is defined according to the available torque characteristics of the combustion engine with consideration for auxiliary power requirements. The current to the pump proportional valves is directly controlled by the measured engine RPM and configurable via parameters settings.

Non-automotive Mode

In non-automotive mode the pump proportional valve current is independent of measured engine speed, allowing fixed engine speed to supply auxiliary functions. The Drive Pedal potentiometer is used as an analog input to command vehicle speed (pump flow).

Creep Automotive Mode

Creep automotive mode is a combination of the automotive and non-automotive modes. The drive pedal potentiometer is used as an analog input to command the pump proportional valve current. The available pump valve current is limited by the automotive drive curve dedicated to this mode type. The actual current to the pump valve is the product of the actual engine RPM, the defined automotive curve, and the actual percentage of drive pedal potentiometer input. Creep automotive is active above a user defined creep start RPM, below this RPM the propel system behaves like automotive mode. The motor valve current follows the automotive curve.

System Modes and Selection

The application supports up to four system modes. Each of the four selectable system modes can be configured as one of the three propel methods (automotive, creep automotive, non-automotive).

All advanced functions (CSD, antistall, overspeed protection, etc) are available for use with every Propel Method.

System modes define the basic characteristic of the transmission and they are selected via two digital inputs: mode switch A and B. Four different and independent drive curves with individual ramping for pump and motor can be selected by the system mode switches, allowing individually optimization of the driving behavior in each mode.

System Mode Selection (Hardware)

		System Modes			
		Mode 1	Mode 2	Mode 3	Mode 4
Mode switch A		Low	Low	High	High
Mode switch B	Nominal	Low	High	Low	High
	Redundant	High	Low	High	Low

Advanced Functions

Inch Function

The inch command destrokes the pump in order to decelerate the vehicle while maintaining/increasing engine speed to meet auxiliary function requirements. Inch function profile and interaction with propel motor are configurable. Engine overspeed protection monitors engine speed during the inch function to prevent the engine from over speeding when the load is reduced.

Drive Curve with Independent Pump/Motor Profiling and Ramping

The pump and motor can both be independently configured for the forward and reverse driving direction. The software application facilitates individual command profiles (8pts) based on pump RPM or drive pedal inputs. Additionally vehicle acceleration timing (1 ramp) and deceleration timing (3 ramps plus 1 error ramp) are independently configurable.

Constant Speed Drive

This CSD function (CSD by pump flow) calculates pump flow via pump speed and predicted pump swash plate angle. Swash plate angle is predicted based on factory calibrated pump valve current relationship. The software will calculate the desired motor speed based on the predicted swash plate angle, actual pump rpm, and the maximum motor displacement. If the actual vehicle speed differs from the commanded speed, the software proportional-integral (PI) control will adjust the pump valve current to compensate for the speed difference.

This function requires motor or vehicle speed sensor but can be used without a drive pedal input.

Vehicle Speed Limiter

The vehicle speed limit is a general vehicle speed limitation that compensates for volumetric pump and motor losses. This function can be independently activated in each system mode and driving direction. If the actual vehicle speed exceeds the defined vehicle speed limit the software PI controller function will reduce pump valve current until the speed limit is met.

This function requires a motor or vehicle speed sensor.

Engine Overspeed Protection

- The engine overspeed protection prevents the engine from over speeding while inching and when actual engine speed exceeds the user defined RPM. This protection function is only activated while inching.
- In case of engine over speed due to downhill driving (exceeding the braking performance of the engine) mechanical brakes are needed to protect the engine.

Motor Overspeed Protection

The motor over speed protection (MOP) prevents the hydrostatic motor from over speeding by either decreasing pump displacement or increasing motor displacement (only applies to electrical proportional motor control). The motor RPM speed limit, based on a software PI algorithm, is user defined but is universally constant for all four system modes when activated.

The engine overspeed protection (EOP) during inching (see above, Engine Over Speed Protection) has priority and will override the motor over speed protection (MOP).

Advanced Functions (continued)

Engine Anti-Stall

- The engine anti-stall prevents the engine from being stalled due to overload through the transmission system. There are two independent engine anti-stall modes: fixed engine RPM and all range engine RPM.
- Fixed engine RPM: fix engine RPM anti-stall is used in applications operating at fixed engine speeds. If the actual pump speed droops below the target fixed engine speed the software PI controller will reduce the pump valve current to achieve/maintain the target fixed engine speed.
- All range engine RPM: the engine speed command and the actual pump speed will be compared to calculate the engine speed droop. If the actual pump speed is below the user defined engine speed droop the software PI controller will reduce the pump valve current to reduce engine load and prevent further engine speed droop.
- The engine anti-stall function can be individually enabled for each system mode.

Flow Limitation and Control

The system flow limitation uses the pump swash plate angle sensor information (option AC2) to limit the vehicle speed for a fixed displacement motor. The software calculates vehicle speed based on measured swash plate angle, actual pump speed, fixed motor displacement, gear ratio, and the wheel diameter. If the calculated vehicle speed is above the defined vehicle speed limit the software PI controller function will reduce pump valve current until the speed limit is met. This function can be independently activated in each system mode and driving direction.

Load Independent Swashplate Control

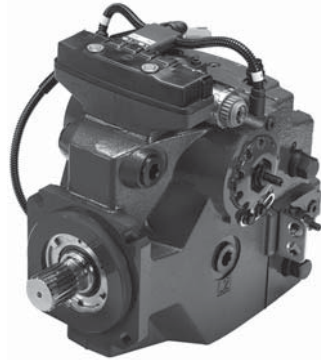
The load independent swash plate control maintains commanded swash plate position independent of load (EDC behavior) using electronic feedback from the pump swash plate angle sensor. The function can be individually configured in each system mode. The pump swash plate angle sensor calibration is performed at the factory.

Temperature Compensation

The temperature sensor integral to the controller's printed circuit board (PCB) measures the PCB board temperature. The pump case oil temperature and oil viscosity are assumed to be proportional to the measure PCB board temperature. The function compensates for oil viscosity impact by decreasing the pump valve current command at cold start and increasing the pump valve current command at high operational temperatures.

Overheat and Low Temperature Protection

The hydraulic system overheat protection and low temperature pump flow limitation functions are based on the electronic board integrated temperature sensor which measures PCB temperature. The function protects the complete hydrostatic system by reducing the pump flow (pump valve current reduction) at extreme high or low temperatures according to a user defined temperature dependent limitation curve.

Pump

F500018

- H1 Axial Piston Pumps with integrated Automotive Control (AC)
- Vehicle propel transmission microcontroller integrated on pump control
- Complete propel drive system functionality embedded in microcontroller
- Optional SIL-2 certification simplifies vehicle certification

Motors

The H1 AC propel transmission programming has been optimized for the H1 bent axis variable displacement motors, but can work with a wide variety of motors from the Sauer-Danfoss portfolio, including those listed below.

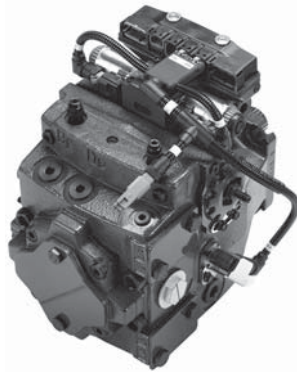


F301602

- H1 Bent Axis Variable Displacement Motors
- Series 42 Axial Piston Motors
- Series 90 Axial Piston Motors

The H1 Automotive Control is a PLUS+1 Compliant solution, designed to be compatible with the range of other PLUS+1 compliant components in the Sauer-Danfoss product portfolio, examples of which are highlighted below.

Integrated Automotive Controller



F500019

- Complete propel drive system functionality
- PLUS+1 Service Tool configurable for custom drive behavior
- PLUS+1 Compliant pump and motor control, pedal, joystick, and sensor options

H1 Speed Sensor

The H1 speed sensor is a required option for the H1 AC pump and an optional feature for the H1 motor.



F500000

- Designed for rugged outdoor, mobile or heavy industrial speed sensing applications.
- Ideal for high and low speed measurements and sensing the direction of rotation.
- Capability to detect the H1 pump or motor case oil temperature.

KEP Electronic Foot Pedal

The KEP Electronic Foot Pedal is used to drive vehicles equipped with hydrostatic transmissions and/or electronically-controlled engines.



F101881

- Provides an electrical signal to the engine's electronics proportional to the degree of pedal actuation.
- Features a sensor specifically designed for heavy vehicle applications.
- Provides hydrostatic braking, inch, drive or creep command signal.

Joystick*JS1000*

F101431

- High-reliability operator input device for controlling mobile machine work functions.
- Available in single axis spring-centered and dual axis spring-centered configurations.
- Resistant to the extremes of temperature, shock, vibration, and EMI/RFI typically found in mobile machine operating environments.
- Uses non-contact Hall effect technology.
- Output options:
 - Analog
 - CAN 2.0B, J1939 protocol
- Provides the drive command signal.

JS6000

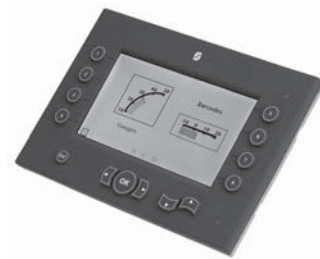
F101890

- Metal construction with a large diameter stainless steel operating shaft, an innovative ball and socket gimbal design manufactured from pressure die cast zinc alloys, a custom high strength material for the center return cone, and optional contactless Hall effect sensing technology.
- Many options, making it the right choice for applications that require more than a simple dual axis joystick with spring return to center.
- Output options:
 - Analog
 - CAN 2.0B, J1939 protocol
- Provides the drive command signal.

**Graphical Terminals
and Displays***DP200*

F301607

- Cost effective alternative to existing analogue gages.
- High-resolution monochrome displays fit every budget without compromising performance.
- Options featuring front USB 2.0 port for easy connection to PC-based service and diagnostic tools, extended IO for improved input design flexibility, real-time clock, display heater, and Engine Information Center (EIC), J1939 software.

DP600

F301609

- For high-end applications, these sophisticated graphical terminals provide optimal performance and flexibility.
- Transflective TFT and DSTN, LCD display technologies, high resolution display, antiglare screen, and sensor controlled backlighting.
- CAN, RS-232 and USB interfaces.
- Additional inputs for an external navigation button, which enables you to maneuver through all terminal functions.

Ordering Process

The Automotive Control software is specified by the customer for prototypes according to the Functional Option Packages in section Y (settings) of the H1 pump model code. Once final parameters are selected by the customer during prototype testing, a customer specific H1 pump material number is created with the proprietary settings. In the case of both prototype and production H1 AC pump deliveries, the complete software programming is factory loaded onto the embedded AC controller.

How to Download Service Tool Software from the Sauer-Danfoss Web Site

To download service tool software and obtain a free service tool license:

1. Go on line to: <http://www.sauer-danfoss.com/Products/MobileElectronics/PLUS1Guide/PLUS1GuideDownloads/PLUS1GUIDEServiceToolSoftwareLicense/index.htm>.
2. Download .exe file.
3. Click on *How to obtain a free license for the PLUS+1 Service Tool*.

Specific .P1D and .PLG files relative to customer prototype or production H1 AC pumps will be provided by Sauer-Danfoss to designated customer contacts at time of initial pump delivery, or can be accessed in the application software download page <http://www.sauer-danfoss.com/Products/MobileElectronics/PLUS1Guide/PLUS1GuideDownloads/Application Software for Microcontrollers>.

SIL 2 Certified H1 AC Systems Service Tool Software

For H1 AC systems that are SIL 2 certified, it is necessary to use a SIL 2 certified version of the GUIDE Service Tool in order to access the H1 AC controller or upload, download, and change system parameters. Instructions for how to obtain a SIL 2 certified service tool version approved for use with SIL 2 certified H1 AC systems is outlined below:

1. Go on line to: <http://www.sauer-danfoss.com/Products/MobileElectronics/PLUS1Guide/PLUS1GuideDownloads/Application Software for Microcontrollers>.
2. Download Service Tool .exe file.

The service tool version contained in the H1 AC download area may be different than the general market service tool as described in the previous section above.

3. Click on *Service Tool Read Me*.

Application Software Overview

The H1 AC utilizes PLUS+1 Service Tool to customize the transmission configuration and performance, as well as to display operational data for field service, and troubleshooting.

Cooperative development with pilot customers has contributed to the availability of extensive functionality programming adaptable to a wide variety of vehicle applications, and the ability to tailor H1 AC performance to meet the unique requirements of each OEM.

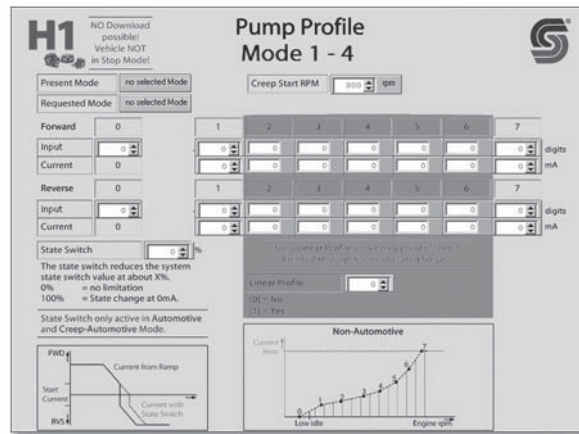
Please reference *H1-Automotive Control PLUS+1 TM Compliant User Manual, 70012797*, as well as the technical information manual for your H1 pump size, for further information ranging from basic functionality in a Quick Start Guide to more advanced functions configuration capabilities of the H1 AC.

Application Software Overview (continued)

Service Screens

The PLUS+1 Service Tool can be used to modify and tune the performance of the transmission system through individual parameter settings. The service tool has two basic screen types:

PLUS+1 GUIDE Service Tool Parameter Functions Screen

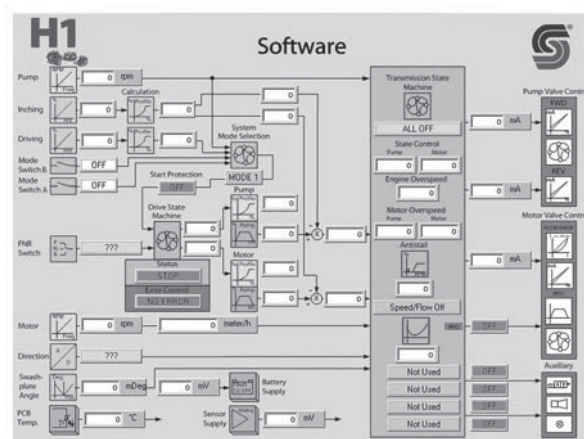


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Parameter Functions screens

The parameter functions screens show the configurable system parameters for tuning the transmission system according to customer requirements.

PLUS+1 GUIDE Service Tool Log Functions Screen



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Log Functions Screens

The log functions screens show operational data of the transmission system. The operational data is useful for understanding the system behavior, tuning the system performance, and trouble shooting. The data can also be logged and stored (via external computer interface) for documentation and off line analysis.

**Application Software
Overview (continued)**

User Interface

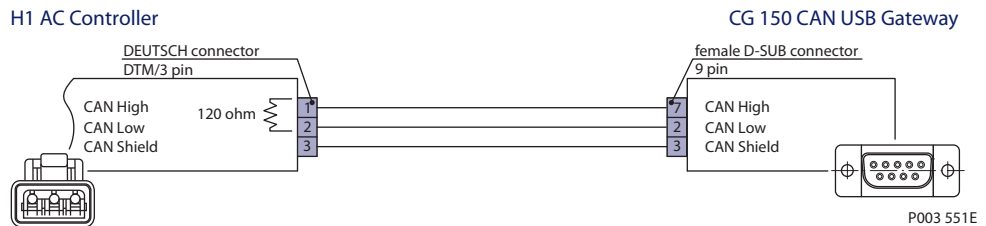
A simple laptop connection directly to the H1 AC controller allows both customization of the system configuration and performance parameters as well as accessing operational data in log functions for service and troubleshooting requirements. For the convenience of our customers, Sauer-Danfoss makes available the CG150 CAN Gateway laptop computer cable and an adapter cable to connect the CG150 to the H1 AC controller. Specifications are also provided to enable customers to source their own dedicated cable if desired.

CG150 CAN Gateway



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Adapter Cable



P003 551E

Cable Material Numbers

CG150 CAN Gateway	10104136
Adapter cable	11069593



Integrated Automotive Control
System Description
Notes



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System Description
Notes



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System Description
Notes

Our Products

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 Bent axis motors
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