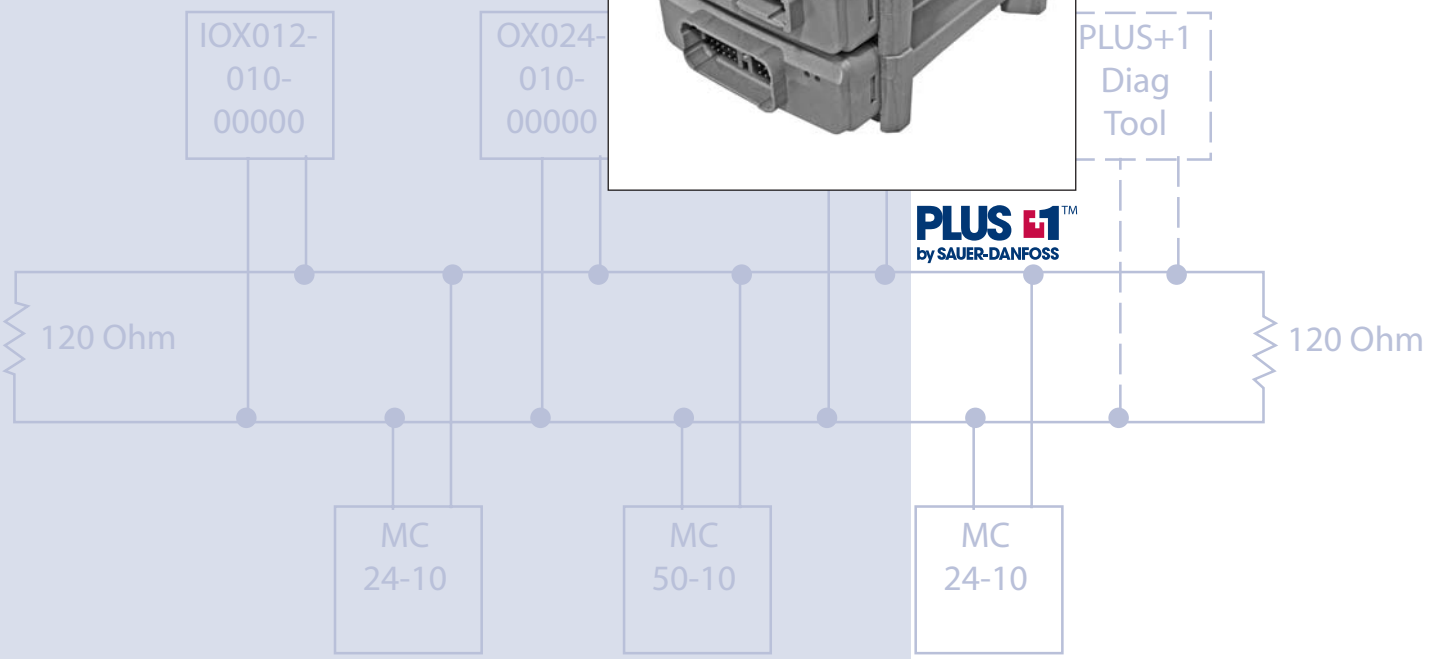
SAUER DANFOSS

PLUS+1 CAN I/O Module Communications

Technical Information



PLUS+1™ CAN I/O Module Communications Technical Information

Contents

Revision history

Revision date	Page	Change	Remarks
12/16/2005			Initial release

Front cover illustrations: F101421, F101422, F101423, F101425, 2326

ABOUT THIS MANUAL

This publication explains the protocol design of the PLUS+1 CAN I/O communication. It will show the necessary parts of the design and their interaction.

Applicable documents

DM	SPRS1741 (i)	TMS320F2810 TMS320F2812 - Digital Signal Processors Data Technical Information (Texas Instruments)

References

SFS	D-270405-1, 1.14	Smart Flash loader Specification (Smart GmbH)
DS301	DS301, 4.00	Application Layer and Communication Profile CiA (CAN in Automation)
2.0	CAN2spec, 2.00	CAN Specification (Bosch®)
J1939	Data Link Layer	Surface Vehicle Recommended Practice – J1939-21 (SAE)

Definitions and abbreviations

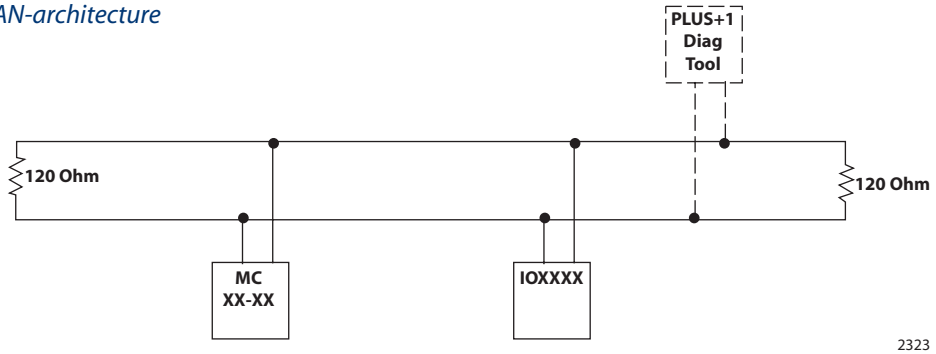
CAN	Controller Area Network
CRC	Cyclic Redundancy Check
CPU	Central Processing Unit
ECU	Electronic Control Unit
EEPROM	Electrically Erasable and Programmable Read Only Memory*
Kernel	Set of hardware dependant driver functions and operating system
OTP	One-Time Programmable
RAM	Random Access Memory
ROM	Read Only Memory
LSB	Least Significant Byte
MSB	Most Significant Byte
PDO	Process Data Object (CAN Open Terminology) [DS301]
Tx	Transmit
Rx	Receive
I/O	Input/Output
MC	Master Controller in the network (for example: MC024-010 or MC050-010)
0x	In front of a number defines a base 16 number (hexadecimal)
CAN-Bx	CAN Data Byte number X, counting of these bytes start from zero

* This phrase is still used, even if the selected device is re-programmable

SYSTEM OVERVIEW

Besides the programmable members of the microcontroller family like the MC024-010 and MC050-010, the PLUS+1 platform needs different I/O expander modules. There is always the chance that some additional requirements will need extra inputs or outputs to the system. If the controllers already in the system are out of I/O, it may make sense to add an inexpensive I/O module to the system rather than stepping up to a higher performance controller.

CAN-architecture



SYSTEM CONTEXT

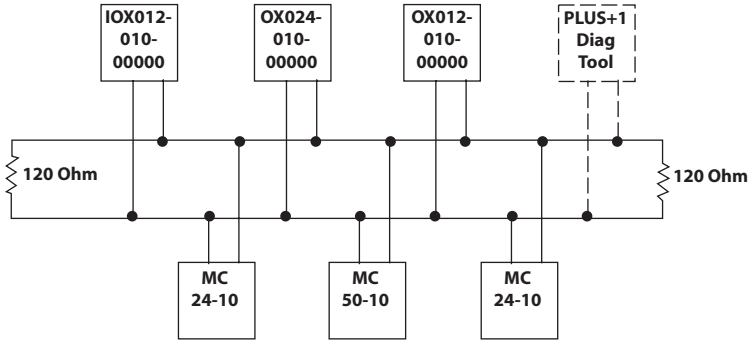
PLUS+1 family with five different I/O units

IX012-010-00000	12 pin input
IX024-010-00000	24 pin input
OX012-010-00000	12 pin output
OX024-010-00000	24 pin output
IOX012-10-00000	12 pin input/output

You can use more than one I/O device in the same network. It is also possible in *Sauer-Danfoss only networks** to replace one unit without additional service actions.

CAN-bus with several PLUS+1 MC and I/O Modules

Service tool interface



The I/O modules have a *bootloader* program. You can update the firmware using the PLUS+1 service and diagnostic tool. Use the *downloader* from the *service tool* to load a new .lhx file.

**Sauer-Danfoss only network* means that only PLUS+1 compliant units are connected on the CAN-bus.

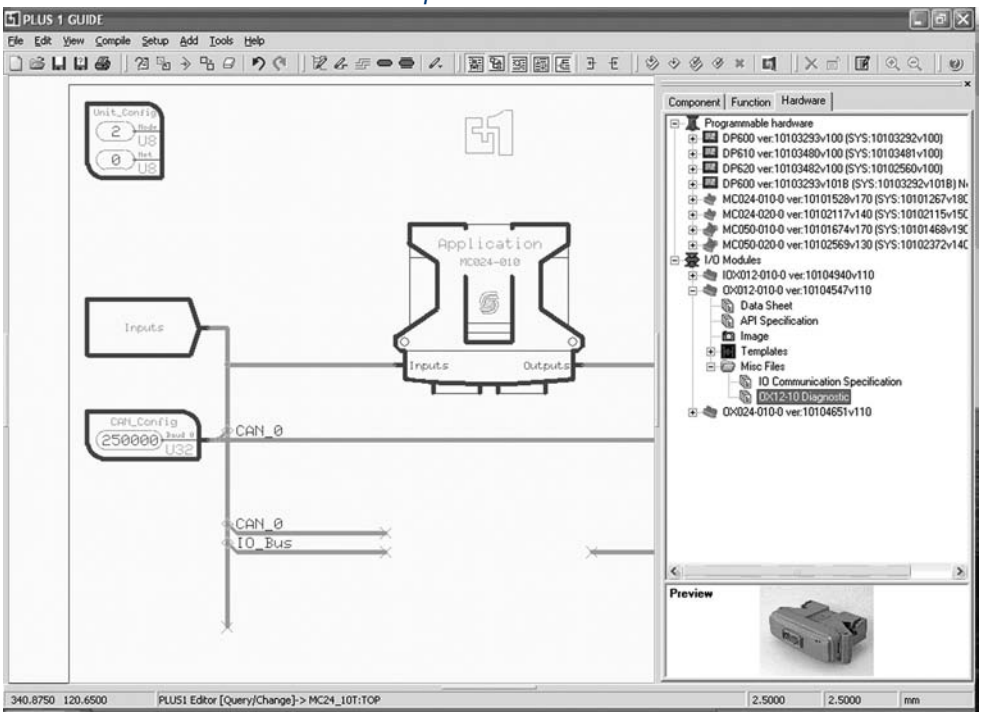
SYSTEM CONTEXT (CONTINUED)

Service tool interface (continued)

You can also use the service tool to change the default addressing mode of the I/O modules. This might be necessary in some circumstances. The service tool and the desired I/O module must be the only devices on the CAN-bus. You can also use the service tool to monitor the configuration and status of the outputs.

To use the service tool, you must first save the *diagnostic (.p1h) file* for the specific I/O module hardware that you are using. This file is available under the *misc files* in the *hardware tab* on the right side of the PLUS+1 GUIDE screen. Right click on the file and save it to your local hard drive.

PLUS+1 miscellaneous files screen example



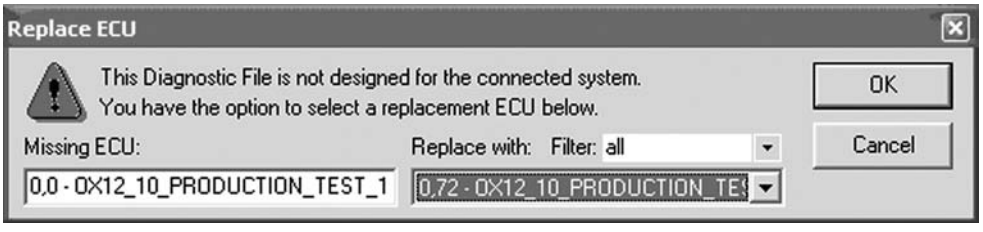
2229

Now that the file is saved to the local hard drive, open it with the service tool.

Remember that it is a .p1h file, not a .p1d file. (.p1h indicates that it is associated with a particular hardware, not an application.)

When you open the .p1h file you may get the following dialog box.

PLUS+1 GUIDE dialogue box example



2230

SYSTEM CONTEXT (CONTINUED)

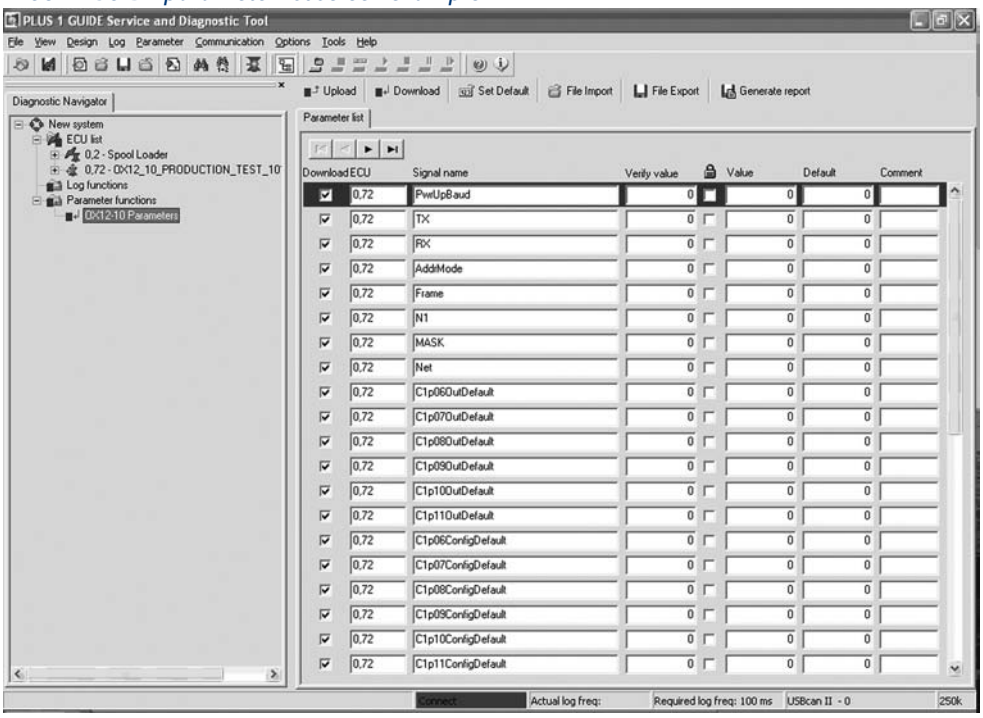
Service tool interface (continued)

Simply click the drop down box on the right and select the actual hardware that is in your system. The reason for this is that the CAN-ID of the numeral 0 (zero) on the left doesn't match the CAN-IDs that are in your system. You need to tell it where the I/O module that you are selecting is located.

Next, you can click on the Parameter function for your I/O module in the *diagnostic navigator*. This will bring up a parameter list for the I/O module.

This parameter screen will allow you to view and change all of the configuration data for the I/O module.

PLUS+1 GUIDE parameter list screen example



2231

Any change of the communication parameters requires a restart of the I/O device for the changes to take effect.

SYSTEM DESIGN

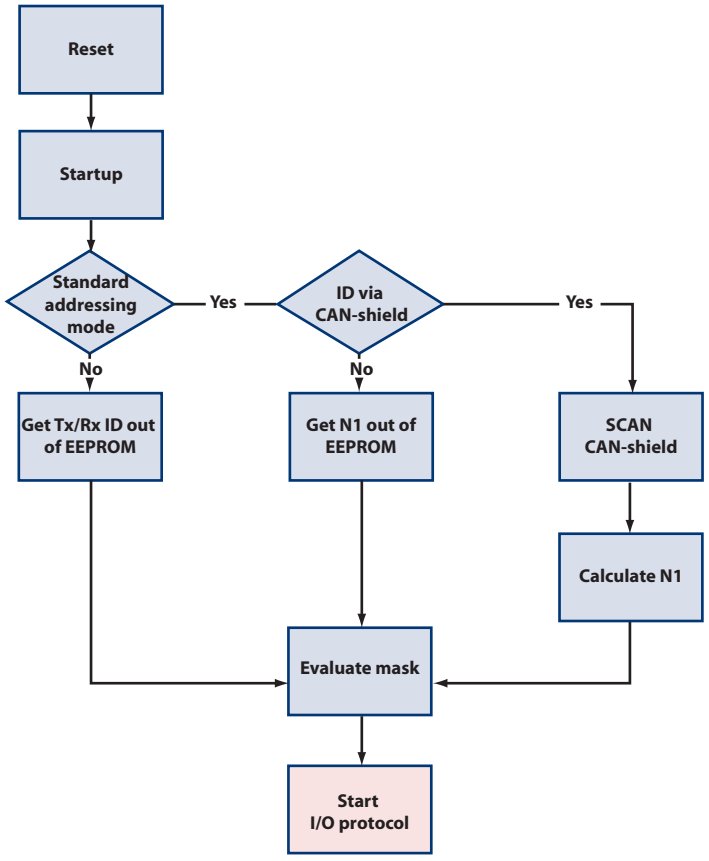
CAN-ID

To minimize the number of CAN identifiers (CAN-ID) used, each I/O device uses just one CAN-ID to transmit data.

To run several devices on one network, each needs a different CAN-ID. After production all units start with the same standard default addressing mode. In the default addressing mode the devices scan the CAN-shield pin at startup and measure the voltage level at this pin. The CAN-ID is set based on this voltage. The default startup configuration is designed to create no conflicts with existing higher layer protocols in regards to the CAN-ID usage.

The addressing mode can be changed with the service tool to a set of default identifiers.

Default configuration flow chart



2325

DECOMPOSITION DESCRIPTION

The default startup configuration of I/O devices is designed to create as few conflicts as possible with existing higher layer protocols in regards to the CAN-ID usage. Due to the restricted CAN-ID range, the system will use the first data byte as a kind of sub-identifier.

Non time-critical messages and configuration messages use a special sub-identifier (0xFF) to enter a new page of commands. In this page the second data byte works as a sub-command.

CAN-ID USAGE

The I/O device can provide up to three different ways of using the CAN-ID.

Variable identifier usage define with CAN-shield

In the default configuration the system uses 11-bit identifiers according to CAN2.0 Part A. The usage of 11-bit identifiers means that the communication happens in the proprietary area of SAE J1939. To work in parallel on a CAN-open bus, the addressing scheme works on PDO (DS301).

The CAN-open default PDOs (CAN-IDs) are defined with a function code (bit 10...bit 7) and the node ID (bit 6...bit 0).

PDO CAN-ID

Most significant bit **Least significant bit**

10	9	8	7	6	5	4	3	2	1	0
P	P	P	P	N	N	N	N	N	N	N

P	4 bits – PDO
N	7 bits - node ID

PDOs defined

PDO1 Tx 0x180+node ID
PDO1 Rx 0x200+node ID
PDO2 Tx 0x280+node ID
PDO2 Rx 0x300+node ID
PDO3 Tx 0x380+node ID
PDO3 Rx 0x400+node ID
PDO4 Tx 0x480+node ID
PDO4 Rx 0x500+node ID

CAN-open allows the node ID to range from 1 to 127.

The I/O devices will use PDO1 Tx *to transmit* and PDO2 Rx *for receive*. This avoids collision if someone in a proprietary system uses a node ID larger than 127.

PDO Node ID usage

The node ID consists of 7 bits. The node ID is divided into two sections

a) to address the requirements of different devices on the same network
b) so that one device is able to listen to more than one MC

CAN-IDENTIFIER USAGE (CONTINUED)

PDO CAN-ID with divided node-id

Most significant bit **Least significant bit**

10	9	8	7	6	5	4	3	2	1	0
P	P	P	P	N1	N1	N1	N1	N0	N0	N0

Bit definition

P	4 bits - PDO
N1	4 bits - node ID defined by voltage
N0	3 bits - node ID defined for multi MC receive communication

N0 definition

N0 is always set to zero for the PDO1 Tx message. N0 is also zero for the standard PDO2 Rx message, but it is possible to apply the mask value to receive all possible configurations for N0.

N0 usage in PDO

N0	Tx	Rx
0x00	Default, valid	Default, valid
0x01	Invalid	Only with masking
0x02	Invalid	Only with masking
0x03	Invalid	Only with masking
0x04	Invalid	Only with masking
0x05	Invalid	Only with masking
0x06	Invalid	Only with masking
0x07	Invalid	Only with masking

N1 definition

N1 is always assigned at start-up by scanning the analog/shield input. The input range is divided into 16 equal sections, each with a size of 300 mV, starting at 0 V. Any voltage higher than 4.5 Vdc will be interpreted as the highest input value.

N1 calculation

AD-Input low value (mV)	AD-Input high value (mV)	N1	N1 (hex)	N1 (hex pos)	Tx	Rx
0	299	0	0x00	0	0x0180	0x0300
300	599	1	0x01	0x08	0x0188	0x0308
600	899	2	0x02	0x10	0x0190	0x0310
900	1199	3	0x03	0x18	0x0198	0x0318
1200	1499	4	0x04	0x20	0x01A0	0x0320
1500	1799	5	0x05	0x28	0x01A8	0x0328
1800	2099	6	0x06	0x30	0x01B0	0x0330
2100	2399	7	0x07	0x38	0x01B8	0x0338
2400	2699	8	0x08	0x40	0x01C0	0x0340
2700	2999	9	0x09	0x48	0x01C8	0x0348
3000	3299	10	0x0A	0x50	0x01D0	0x0350
3300	3599	11	0x0B	0x58	0x01D8	0x0358
3600	3899	12	0x0C	0x60	0x01E0	0x0360
3900	4199	13	0x0D	0x68	0x01E8	0x0368
4200	4499	14	0x0E	0x70	0x01F0	0x0370
4500	—	15	0x0F	0x78	0x01F8	0x0378

CAN-IDENTIFIER USAGE (CONTINUED)

Predefined identifier usage with fixed N1

In this configuration the N1 portion of the CAN identifier is predefined by Sauer-Danfoss. It can be adjusted by the OEM with the PLUS+1 service and diagnostic tool.

Fixed identifier usage

This special configuration works only with fixed identifiers. These identifiers are configurable with the diagnostic tool. Also in this configuration it is possible to apply a mask for receiving messages. It is also possible to select between 11 bit and 29 bit identifiers.

KWP2000 NODE and NET ASSIGNMENTS

In addition to the I/O protocol the I/O devices also need to support the PLUS+1 service and diagnostic tool protocol. This is based on KeyWord Protocol 2000 (KWP2000.) Basic parameters for this are the *node* and *net* number. The following sections describe how these numbers are assigned.

KWP2000 node number

The node number is assigned by using N1 as the KWP2000 node number as shown below in variable identifier and predefined identifier addressing mode:

KWP2000 node number

Most significant bit **Least significant bit**

7	6	5	4	3	2	1	0
X	N1	N1	N1	N1	X	X	X

X	Not used = 0
N1	4 bits - node ID defined by voltage or with fixed value

KWP2000 net number

The *net number* is stored as a parameter in the non-volatile memory and can be modified with the PLUS+1 service and diagnostic tool.

LED HANDLING

To simplify system diagnostics the I/O device will use its LEDs, if available, to indicate different status conditions.

Red LED

The red LED indicates outgoing message traffic from the I/O device. The LED toggles its state with every successfully transmitted frame.

If the device's CAN-bus goes into a *bus off* condition then the LED will be permanently on.

Green LED

The green LED indicates that the I/O device is seeing incoming message traffic. The LED toggles its state with every successfully received frame. If no messages are received for more than 10 seconds, then the LED starts to blink at a one Hertz rate.
Time critical messages and messages which have to be used all the time are implemented with a sub identifier which has a value from 0 to 0xFE.

Notes

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Sauer-Danfoss (US) Company
2800 East 13th Street
Ames, IA 50010, USA
Phone: +1 515 239-6000, Fax: +1 515 239 6618

Sauer-Danfoss (Neumünster) GmbH & Co. OHG
Postfach 2460, D-24531 Neumünster
Krokamp 35, D-24539 Neumünster, Germany
Phone: +49 4321 871-0, Fax: +49 4321 871 122

Sauer-Danfoss (Nordborg) ApS
DK-6430 Nordborg, Denmark
Phone: +45 7488 4444, Fax: +45 7488 4400

www.sauer-danfoss.com

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