

## Description

The SSC Mass Calibration System (MCS) enables simple and intuitive handling of calibration and evaluation of a larger number of sensor systems based on IDT's Sensor Signal Conditioner ICs (SSCs). An evaluation of different mass calibration procedures for subsequent series production is possible earlier in the product development phase. This allows an optimized product design that can meet the requirements of cost-effective mass manufacturing and mass calibration.

The primary circuit board for the MCS is the Mass Calibration Board (MCB), which communicates with the user's computer via the SSC Communication Board (SSC CB). For each MCB, up to 24 devices under test (DUTs) can be calibrated, and up to eight MCBs can be connected in series to a single SSC CB, allowing mass calibration of up to 192 DUTs.

Three digital interfaces are supported: I2C, one-wire interface (OWI), and Local Interconnect Network (LIN)\*. The analog output voltage of each DUT can also be monitored and measured. The user can adjust an individual board address manually, and each MCB can be controlled via the mass calibration software installed on the user's computer. Individual configuration and calibration of DUTs is possible by multiplexing the power supply of the DUTs. The serial interface used by the DUTs is adjusted automatically via software. If more than one MCB is used simultaneously, then these adjustments must be identical for proper operation.

Jumper connectors on the MCBs provide access to all power lines. The board can be supplied with 8 to 16 VDC via the on-board 5V linear regulator. To avoid overloading this single power supply line if heavy loads are driven, there are separate power supply interfaces for the MCB, the DUTs, and the I2C serial bus.

## Features

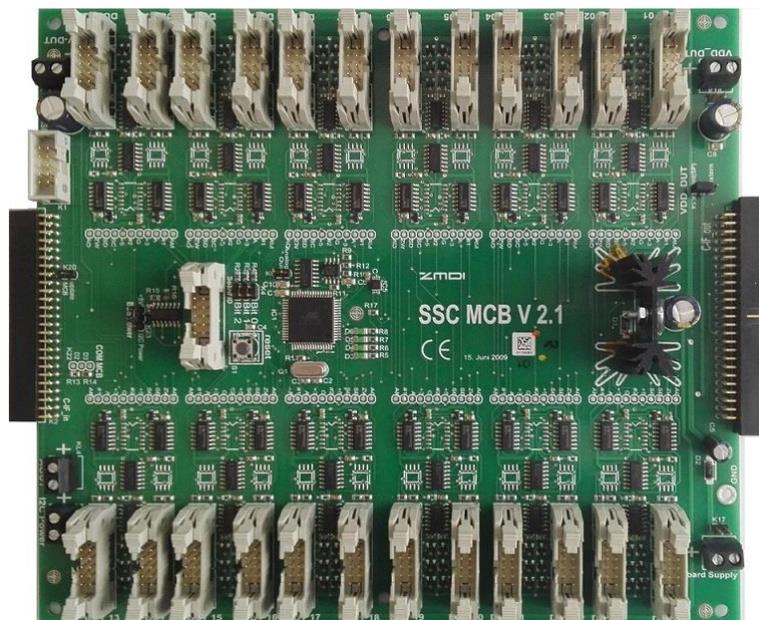
- Multiple sensor module (DUT) access with support for the different digital interfaces of IDT SSC ICs
- Interface to the user's computer via a USB port via the SSC CB, which is also included in IDT's modular SSC Evaluation Kits
- Each MCB interfaces up to 24 DUTs
- Up to 8 MCBs can be connected in series and are addressable separately via one SSC CB, allowing simultaneous calibration of up to 192 DUTs with one system
- Separate power supplies for the MCB, the DUTs, and the I2C bus is possible
- DUT analog output signal measurement
- PC-controlled "plug & play" mass calibration and configuration via USB interface – simple, low cost
- Same ZSSCxxx *Evaluation Software* as for ZSSCxxxx Evaluation Kits – simple installation.

## Contents

- SSC Mass Calibration Board V2.1
- Software is available for download from the product page for the Mass Calibration System (MCS) for the specific DUT product
- The DUTs are connected via standard connectors with mechanical locking

\* The board uses LIN protocol at a voltage level of 5VDC.

## SSC Mass Calibration Board V2.1



**Important Notes**

**Disclaimer**

Integrated Device Technology, Inc. and its affiliated companies (herein referred to as “IDT”) shall not be liable for any damages arising out of defects resulting from

- (i) delivered hardware or software
- (ii) non-observance of instructions contained in this manual and in any other documentation provided to user, or
- (iii) misuse, abuse, use under abnormal conditions, or alteration by anyone other than IDT.

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**Restrictions in Use**

IDT’s Mass Calibration System (MCS), consisting of the Communication Board (SSC CB), Mass Calibration Board (MCB), and the ZSSCxxxx *Evaluation Software*, is designed for sensor module evaluation, laboratory setup and the module’s mass calibration development only.

IDT’s Mass Calibration System (MCS) must not be used for module production and production test setups.

**Firmware Compatibility**

The current version of the SSC CB is V4.1. For previous SSC CB versions, if the firmware version is earlier than V2.19a, the board will not be able to communicate with the SSC Mass Calibration Board V2.1. In this case, it is necessary update the firmware, which can be downloaded from [www.IDT.com/SSC-MCB](http://www.IDT.com/SSC-MCB). For details about the update procedure, refer to the *SSC Communication Board Application Note – Firmware Updates* available at [www.idt.com/ssc-cb](http://www.idt.com/ssc-cb).

**Compatibility with Previous MCB Versions**

If the MCB V2.1 is to be used with a previous version MCB V2.0, refer to the *ZSC31xxx/ZSSC3xxx MCS Application Note – Mass Calibration Board Interaction* (available upon request). Do not connect a previous version MCB V2.0 as the first MCB connected to the SSC CB.

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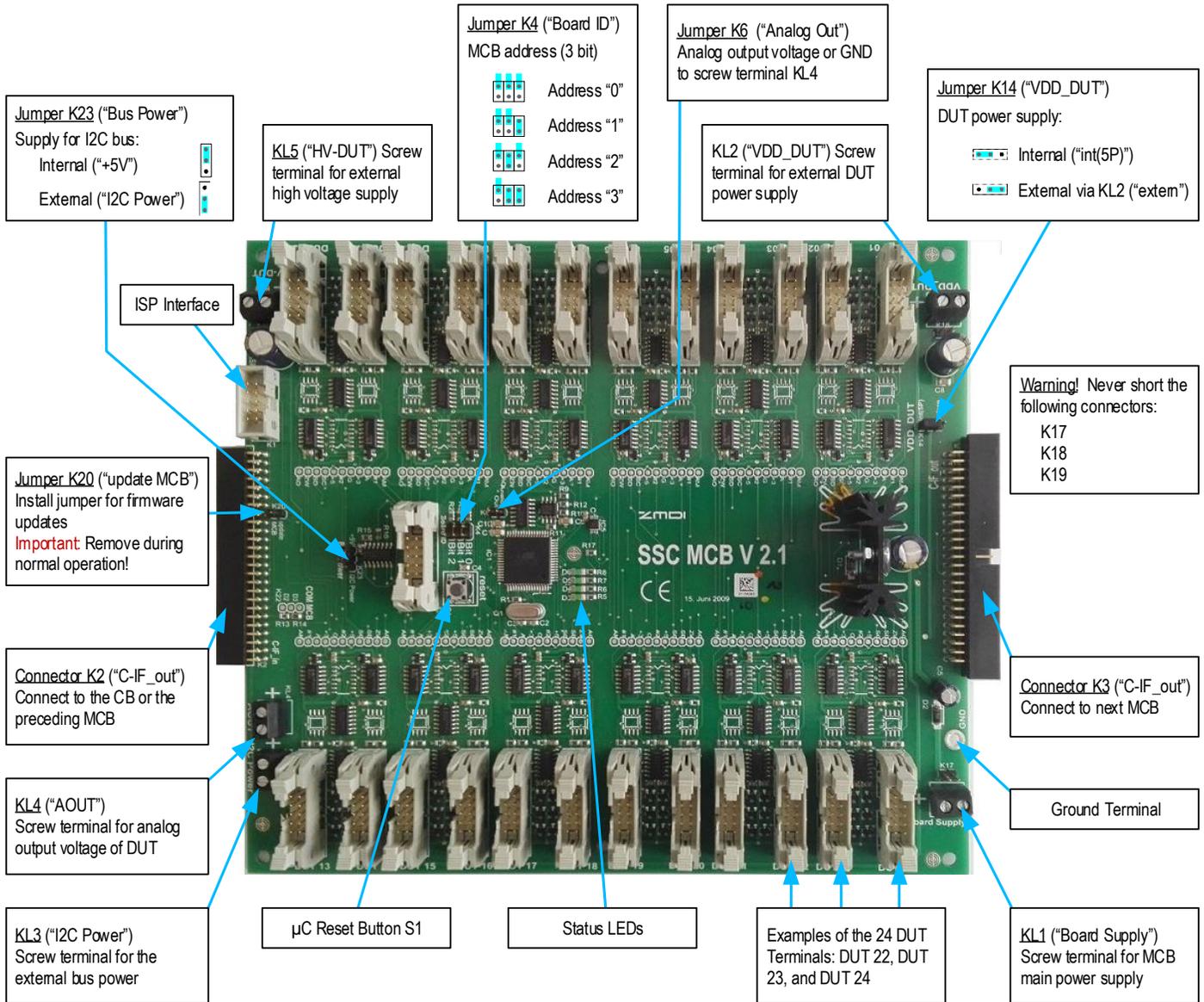
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# 1. MCB – Overview

**Figure 1. Mass Calibration Board (MCB)**



## 2. Pin Assignments

**Table 1. MCB Pin Assignments**

Pin Number (MCB Connectors K2 and K3)	Signal	Description
All even pin numbers	GND	Connected with the negative MCB board supply
1, 3, 5, 7, 9, 15, 17, 19, 21, 23, 31, 33, 37, 43, 45, 47, 49	n.c.	Not connected internally
11	CB-SCL	Buffered clock signal for communication
13	CB-SDA	Buffered data signal for communication
25	OWI	OWI signal from/to SSC CB
27	ADC	Analog output voltage to 10 bit-ADC of SSC CB
29	LIN	LIN signal from/to SSC CB
35	RXD	READ DATA channel of the MCB microcontroller's UART
39	D2	Not used (feedback for MCB V2.0 and thus connected through next MCB)
41	D3	MCB feedback answer

**Table 2. Pin Assignment MCB-Module (DUT)**

Also see Figure 4 for the layout of the connector.

Pin number (DUT terminals)	Signal	Pin Name	Description
All even pin numbers	GND	GND	Connected with the negative MCB board supply
1	VDDA	VDDA	Positive DUT supply (switched by a PMOS)
3	SCL	SCL	Clock signal for communication (only I2C)
5	SDA	SDA	Data signal for communication
7	HV	HV-DUT	Connected to HV-DUT (KL5)
9	AOUT	OWI/LIN	Analog voltage output or OWI/LIN interface

### 3. Electrical Characteristics

**Table 3. Operating Conditions**

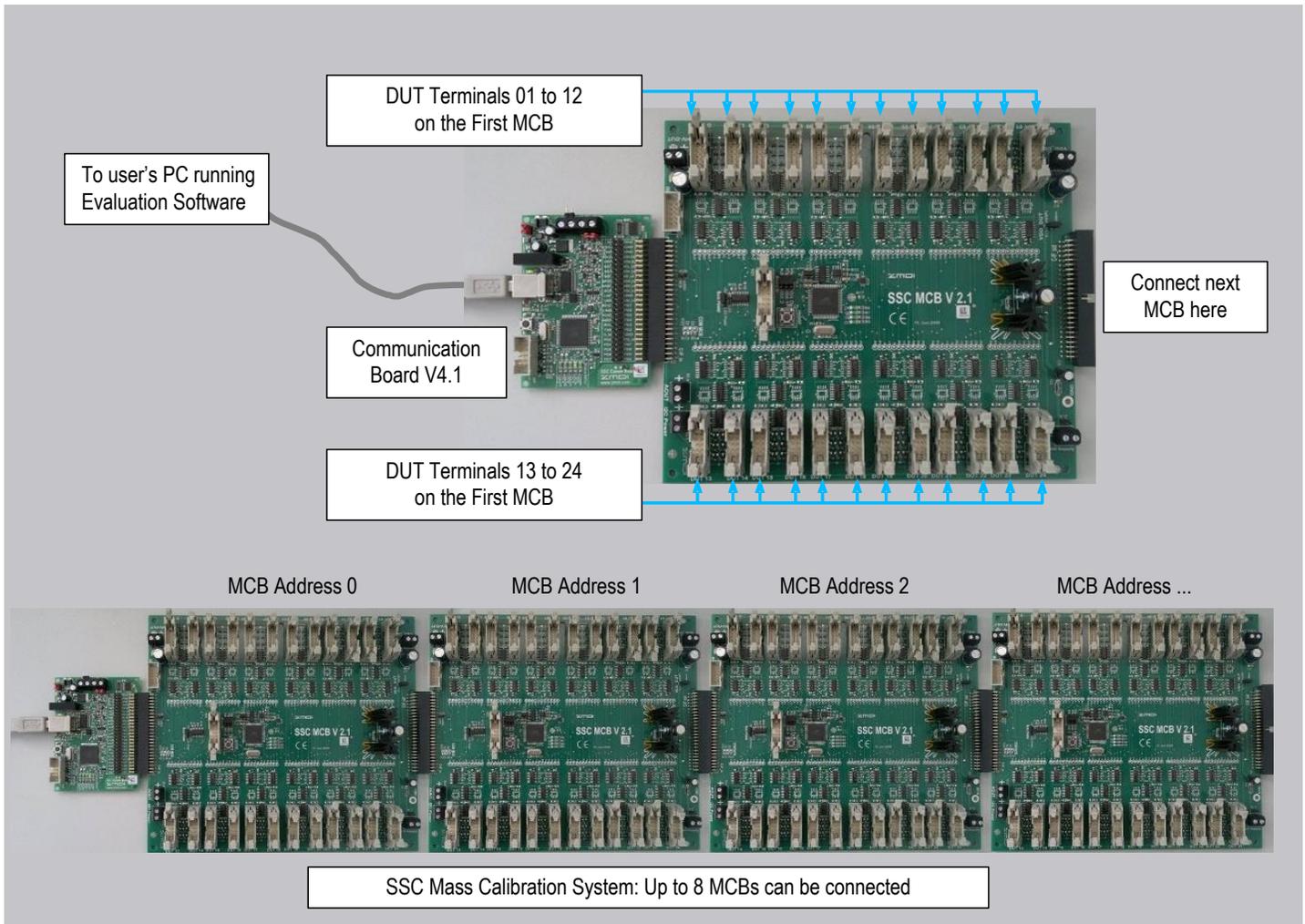
Parameter	Name	Conditions	Min	Max	Units
$V_{SUPP}$ "Board Supply" via KL1 or K17	MCB supply voltage		8	16	VDC
$I_{SUPP}$ via KL1 or K17	MCB supply current	Depends on the number of DUTs connected to the MCB	40	300	mA
$V_{DUT}$ "VDD_DUT" via KL2 or K18	Separate DUT supply voltage		2.7	5.5	VDC
$I_{DUT}$ via KL2 or K18	Separate DUT supply current	Depends on the number of DUTs connected to the MCB		10	mA/DUT
$V_{I2C}$ via KL3	Separate bus supply voltage		2.7	5.5	VDC
$I_{I2C}$ via KL3	Separate bus supply current	Depends on the load to be driven at the I2C bus		100	mA
$V_{OUT}$ via KL4	Analog output voltage of a DUT		0.05	0.95	$V_{DUT}$
$I_{OUT}$ via KL4	Load current at analog output			2	mA
$V_{SUPP}$ via K2	Supply voltage of DUT n	n = (01 to 24 ) per MCB	2.7	5.5	VDC
$I_{SUPP}$ via K2	Supply current of DUT n			10	mA
$V_{HV}$ "HV-DUT" via KL5 or K19	High voltage supply for DUT	Depends on which voltage regulator is used	8	40	VDC
$I_{HV}$ via KL5 or K19	High voltage supply current	Depends on number of DUTs and on which voltage regulator is used		20	mA/DUT

## 4. Circuit Description

### 4.1 General Information

The SSC Mass Calibration Board (MCB) provides the hardware allowing mass calibration of up to 24 DUTs. The system can operate with up to 8 MCBs, allowing calibration of up to 192 DUTs.

**Figure 2. Modular Mass Calibration System (MCS)**



### 4.2 Communication Interface to User's Computer

The SSC MCS is interfaced to the user's computer (PC or laptop) via the SSC Communication Board (SSC CB) provided with the Mass Calibration System (MCS). For a detailed description of the SSC CB, command syntax, software, or USB driver installation (applicable only to SSC CB versions earlier than V4.1), see the documentation for the SSC CB available on the IDT website at [www.idt.com/ssc-cb](http://www.idt.com/ssc-cb).

Communication is managed by the microcontroller on the SSC CB. The SSC CB generates the communication sequence for the DUTs connected and receives the DUT's response. The MCB interprets the full command set and handles powering on and communication access to the DUTs. The MCB receives data via the RXD pin of the SSC CB (connector K3 or K4). The MCB answers via the D3 pin. All connected MCBs are parallel at the port. The SSC CB's answer to the PC can be verified at the TXD pin.

### 4.3 Firmware Version

For SSC CB versions earlier than V4.1, see the important notice on page 2 regarding firmware compatibility.

The MCB's firmware version string can be read via the following command, where the number shown in green is the address of the MCB (see section 4.5). The *SSC Terminal Program* (downloadable from [www.IDT.com/SSC-MCB](http://www.IDT.com/SSC-MCB)) can also be used for this. This command will return the version string of the MCB with this address; for example "1" for the second MCB.

**X1V:X** → read Version string of MCB with address 1

In the event that a firmware update is required for the MCB, the MCB provides an ISP interface to program its own microcontroller. To enable this, short jumper K20 ("update MCB") when the firmware of  $\mu$ C must be updated.

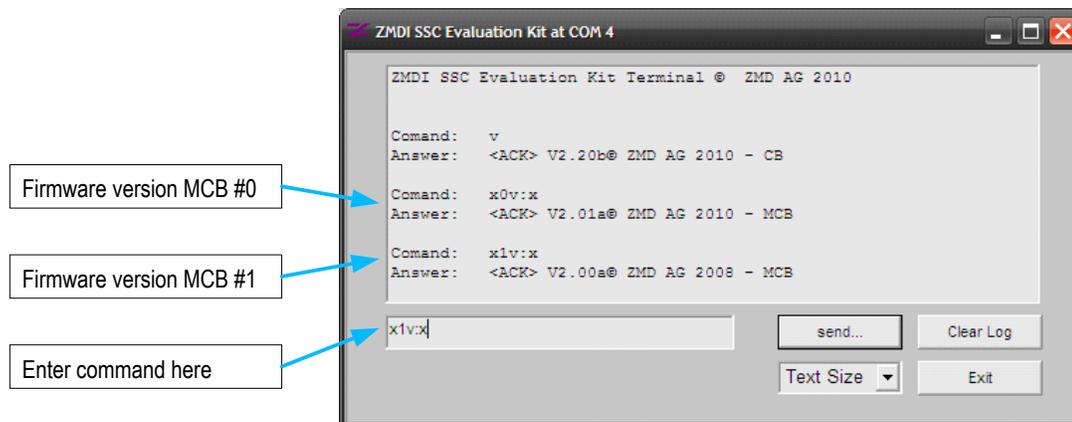
Important: Do not connect the jumper on K20 during normal operation.

The serial communication between the MCB's microcontroller and the CBs microcontroller is via their standard UART interfaces. The *SSC Terminal Program* or any other terminal program can be used to send commands to the SSC CB and MCB. Figure 3 shows the readout of different firmware strings.

COM Port Settings:

- Baud rate: 19200
- Data bits: 8
- Stop bits: 1
- Parity: none

**Figure 3. IDT SSC Terminal Program**



### 4.4 Software for the Mass Calibration System

Refer to the *SSC Mass Calibration System Feature Sheet* for a list of the IDT SSC IC products that can be configured, calibrated, and evaluated using the MCS. Each of these products has its own SSC Evaluation Software, which can be downloaded from the product pages for the individual products on the IDT website [www.IDT.com](http://www.IDT.com). This product-specific SSC Evaluation Software is also used for the MCS. Refer to the documentation for the product's SSC Evaluation Kit for instructions for installing and using the software.

## 4.5 Addressing and Communication Options

The MCB supports I2C, LIN, and OWI communication interfaces. The communication is controlled by the SSC CB's microcontroller only. The MCB's microcontroller only controls the DUT's multiplexing and communicates via a separate channel with the microcontroller of the SSC CB. A multiplexer (IC5 – MAX4634EUB) selects the communication interface. The control signals of the multiplexer are generated by the MCB's microcontroller and are described in section 4.5.1.

A total of eight MCBs can be connected in series via the connectors K2 and K3. The MCB with the hardware address "0" must be connected to the SSC CB at K2 (see Figure 2). The address for each MCB must be set manually to a unique address via the position of jumper shunts on K4 on each board (see Figure 1). The MCB's addresses must be in sequence (inverted logic: floating jumper = "0"). The D4, D5, and D6 LEDs display the configured address of the MCB. Details about setting the MCB address can also be found in Table 6.

A bus repeater (IC3 – P82B96T) interfaces between the two voltage levels at KL2 and KL3. This bus repeater has no pull-up resistors on the SDA and SCL pins on the primary side. These pull-ups are not needed because the SSC CB generates the bus levels on SDA and SCL via a 4.7kΩ pull-up resistor. The OWI interface is pulled up with a 22kΩ resistor between connector K2 and the multiplexer IC on the MCB.

On the secondary side, there are 4.7kΩ pull-up resistors. If there are very heavy capacitive loads at the SCL, SDA, or OWI line, it might be necessary to decrease these pull-ups so that drive capability increases and timing requirements of the I2C protocol specification are fulfilled again. Pull-up resistor and communication-line load capacitance must be adapted in the application to the selected communication speed. Communication conditions are described in detail in the IDT datasheet for the SSC DUT.

The MCB provides different pull-ups:

- SCL: Standard 4.7kΩ (additional 1.5kΩ can be switched on)
- SDA: Standard 4.7kΩ (additional 1.5kΩ and 470Ω can be switched on)

If the MCB's pull-up does not fit the communication requirements of the application, then it is possible to add an additional parallel pull-up resistor between the DUT and the connector:

- Pin 1 and pin 3 of the DUT connector for SCL
- Pin 1 and pin 5 of the DUT connector for SDA or one-wire communication

### 4.5.1 Communication Interface Multiplexer

The MCB V2.1 uses a multiplexer to select the communication interface. This IC (MAX4634) selects one communication channel from four input channels. Since only three interfaces are useable, the last input channel is connected to ground. The connection of this IC can also be found in schematic of MCB's Central Control Unit in Figure 7. The multiplexer needs two signals that select the communication interface.

If an MCB firmware version later than V2.00a is used, then these two signals will be controlled automatically by the following command, which enables the communication interface. The firmware version can be detected as described in section 4.3.

- **X9CZ1:X** → Communication interface OWI for **all** MCBs (9) is enabled ("1") → OWI selected
- **X9CZ0:X** → Communication interface OWI for **all** MCBs (9) is disabled ("0") → I2C selected

If MCB firmware V2.00a is used,<sup>1</sup> then in addition to the "X9CZp:X" command, these signals must be set manually via the following commands before an interface command is sent. For details of commands, refer to *SSC Communication Board Command Syntax*.

- **X9PS\_D20:X** → Port **D2** of **all** MCBs (9) is Set to "0"
- **X9PS\_D31:X** → Port **D3** of **all** MCBs (9) is Set to "1"

<sup>1</sup> Firmware version can be detected as described in section 4.3.

Table 4 lists all combinations of pins D2 and D3 and the resulting communication interface.

**Table 4. Interface Configuration**

Pin D3 (Associated Command)	Pin D2 (Associated Command)	Communication Interface
0 (X9PS_D30:X)	0 (X9PS_D20:X)	I2C
0 (X9PS_D30:X)	1 (X9PS_D21:X)	OWI
1 (X9PS_D31:X)	0 (X9PS_D20:X)	LIN
1 (X9PS_D31:X)	1 (X9PS_D21:X)	None (GND)

#### 4.5.2 Using the I2C Interface

For I2C communication, the MCB's pull-up resistors and total capacitive load (load capacitance of DUTs/sensor modules at the SCL and SDA lines and communication cable) must be fitted. See the datasheet for the specific IDT SSC DUT for the I2C protocol and timing details.

#### 4.5.3 Using the OWI Interface

For OWI communication, the MCB's pull-up resistor and total capacitive load (load capacitance of DUTs/sensor modules at the OUT pin and communication cable) must be fitted. A load capacitance of 15nF requires a ~330Ω pull-up resistor, and 2.2nF requires approximately 4.7kΩ. See the datasheet for the specific IDT SSC DUT for OWI protocol and timing details.

#### 4.5.4 Using the LIN Interface

The ZSSC3170 is an IDT SSC DUT that provides a LIN interface. LIN communication using the MCS had not yet been evaluated.

### 4.6 Mass Calibration Reference Board (MCR)

The Mass Calibration Reference Board (MCR) can be used for communication verification of software and the MCB. The MCR supports I2C and OWI communication. Each MCS includes four MCRs, which are product dependent. The MCR also has a sensor bridge replacement. Refer to the product's Evaluation Kit document for details about the MCR.

### 4.7 Analog Voltage Output Measurement

The analog output voltage of an individual DUT can be measured at the KL4 screw terminal if the K6 jumper connector is open. If K6 is shorted by a jumper shunt, then KL4 is shorted directly to GND. The K6 jumper should be left open if the analog voltage output is to be measured. The addressing of the DUT is controlled by the Evaluation Software.

## 5. Setup

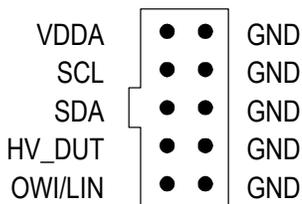
Refer to the *Mass Calibration System Kit Description* for the specific product for specific setup instructions.

### 5.1 Kit Hardware Connections

#### 5.1.1 DUT Control and Connector

DUTs can be connected using the MCB's standard rectangular plug connectors, which have a locking mechanism. The power supply of individual DUTs is switched ON/OFF via a PMOS transistor, which is controlled by the Evaluation Software. This allows the multiplexing of the DUTs and access to individual DUTs via a unique address.

**Figure 4. Pin Assignment of DUT Connector**



Depending on the interface selected (I2C/LIN/OWI), the communication channel is connected via electronic switches controlled by the Evaluation Software (see Figure 4). The LIN interface (see section 4.5.4) is supported by the ZSSC3170 (in place of the OWI interface).

#### 5.1.2 ISP and C-IF Connectors

The MCB has an ISP interface for programming the microcontroller of the MCB. This programming is done at IDT, and it is not necessary to connect this interface.

The connection between the MCB at address 0 (i.e., connected to the SSC CB) and the subsequent MCBs is via a 50-pin connector (refer to Figure 1). These communication interfaces (C-IF) are described in Table 5.

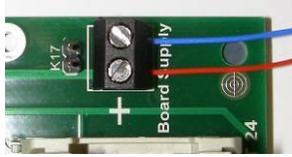
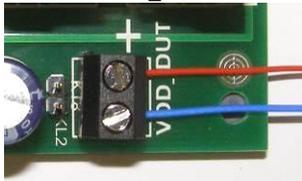
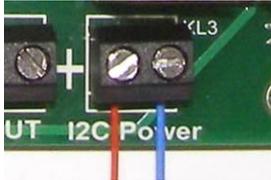
**Table 5. C-IF Connectors**

Screw Terminal	Identifier on MCB	Description
K2	"C-IF_in"	For the first MCB, connect K2 to the SSC CB. Important: Do not connect an MCB V2.0 at this connector (i.e., MCB address 0) to avoid communication problems. See page 2 regarding compatibility with previous version MCBs. For the subsequent MCBs, connect K2 to the previous MCB.
K3	"C-IF_out"	Connect K3 to the next MCB, which can be either an MCB V2.0 or an MCB V2.1.

## 5.2 Power Supply Options

The MCB has four screw terminals for supply voltages as described in Table 6 and shown in Figure 1. See section 3 for specifications for these supply voltages. For jumper settings for different operation modes, refer to Table 6.

**Table 6. Screw Terminals on the MCB V2.1**

Screw Terminal and Related 2-Pin Connector	Identifier on MCB	Description
KL1 (K17)	<p>“Board Supply”</p> 	<ul style="list-style-type: none"> <li>The “Board Supply” power can be connected at either the KL1 screw terminal or the 2-pin K17 connector. <sup>[a]</sup></li> <li>The screw terminal or 2-pin connector is used for an internal power supply of the MCB hardware.</li> <li>This required power supply must be in the range of 8 to 16 VDC.</li> </ul>
KL2 (K18)	<p>“VDD_DUT”</p> 	<ul style="list-style-type: none"> <li>The external “VDD_DUT” power supply is necessary if the DUT is to be powered with a voltage lower than 5V.</li> <li>This DUT power supply can be connected at either KL2 or the 2-pin K18 connector. <sup>[a]</sup></li> <li>A power supply in the range of 2.7 to 5.5 VDC can be connected.</li> <li>See section 5.3 for detailed jumper setting information.</li> </ul>
KL3	<p>“I2C Power”</p> 	<ul style="list-style-type: none"> <li>The external “I2C_Power” power supply is recommended if the external “VDD_DUT” power supply is used.</li> <li>A power supply in the range of 2.7 to 5.5 VDC can be connected.</li> <li>See section 5.3 for detailed jumper setting information.</li> </ul>
KL5 (K19)	<p>“HV-DUT”</p> 	<ul style="list-style-type: none"> <li>An external “HV-DUT” power supply can be connected at either KL5 or the at 2-pin K19 connector <sup>[a]</sup> to provide a high voltage (HV-DUT) at the DUT connector (see section 5.1.1).</li> <li>A power supply in the range of 8 to 40 VDC can be connected.</li> </ul>

[a] **Warning:** Never short-circuit connectors K17, K18, or K19!

The main power supply of the MCB is provided by a standard 7805-type linear voltage regulator. Its primary supply voltage must be within a range of 8 to 16 VDC and connected to KL1. If jumper shunts are installed on K14 to “int (5P)” and on K23 to “+5V,” no additional power supply is needed for DUTs that require a 5V power supply (see Table 6 for detailed information for jumper settings).

For supplying DUTs with voltages below 5 VDC, it is possible to connect an external power supply via the screw terminals KL2 (for the DUTs) and KL3 (for I2C communication). In this case, the K23 jumper connector must be shorted to “I2C Power” and the K14 jumper connector must be shorted with “extern.” Recommendation: Supply both the DUTs and the I2C communication from the same power supply to avoid malfunctions during communication.

To supply DUTs directly with high voltage, a separate HV-DUT power supply connector (up to 40VDC) is provided. This power supply is connected directly to the HV-DUT pin on all DUT connectors. See section 5.1.1 for more details.

The screw terminals KL1, KL2, and KL5 have alternate 2-pin connectors (see Table 6) so that a power supply unit can be easily attached or tested.

The D3 LED displays the status of the power supply for the MCB's microcontroller.

**Figure 5. D3 Status LED for MCB Microcontroller**



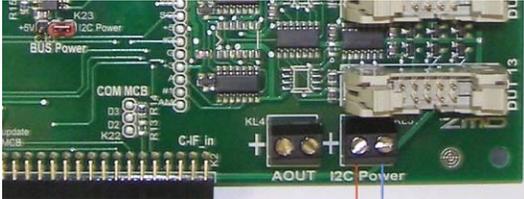
D3 Status LED

### 5.3 MCB Jumper Setup

Table 7 gives a general overview of the MCB jumper settings.

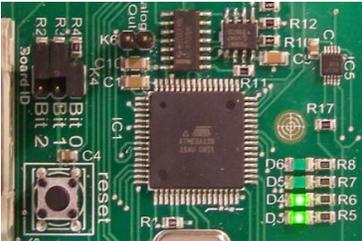
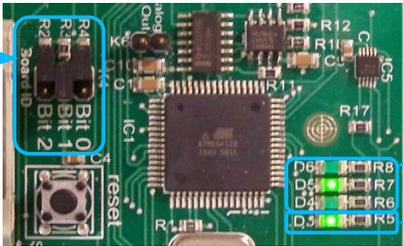
**Table 7. General Jumper Setup for the MCB V2.1**

Jumper	Identifier	Description
<b>Jumpers Related to Basic Functions</b>		
K4 (Address Bits [2,0])	“Board ID” (see Figure 1)	3-bit binary weighted MCB address: <ul style="list-style-type: none"> <li>Assign first MCB to address 000<sub>BIN</sub>.</li> <li>Assign remaining MCBs in ascending order.</li> <li>See Figure 1 for the bit assignments for the jumpers, and see Table 8 for a more detailed description of jumper settings.</li> </ul>
K6	“Analog Out” (see Figure 1)	<ul style="list-style-type: none"> <li>The K6 jumper connector is located near the microprocessor and is in parallel with KL4 (“AOUT”).</li> <li>Leaving K6 open selects the analog voltage output measurement. A jumper on K6 shorts KL4 to ground.</li> </ul>
K20	“update MCB” (see Figure 1)	<ul style="list-style-type: none"> <li>Only install this jumper if the firmware is to be updated.</li> <li>Remove jumper in normal operational mode!</li> </ul>
<b>Jumpers Related to Power Supplies</b>		
K14 “VDD_DUT”	Short center pin to “int(5P)” 	<b>Internal Supply Mode</b> If the K14 jumper is set to “int(5P),” the MCB, DUT, and communication lines are powered by the MCB’s 5V supply voltage regulator (via KL1 with 8 to 16V VDC).
	Short center pin to “extern” 	<b>External Supply Mode</b> <sup>[a]</sup> If the K14 jumper is set to “extern,” the DUTs are supplied with power via KL2 or K18 (VDD_DUT).

Jumper	Identifier	Description
K23 "BUS Power"	Short center pin to "+5V" 	<b>Internal Supply Mode</b> If the K23 jumper is set to "+5V," the communication lines are supplied with the internal +5V.
	Short center pin to "I2C Power" 	<b>External Supply Mode</b> <sup>[a]</sup> If the K23 jumper is set to "I2C," the communication lines are supplied via the KL3 ("I2C Power").

[a] Recommendation: Set both jumpers K14 and K23 to select the external supply mode, and supply both the DUTs and the I2C communication supply from the same power to avoid malfunctions during communication.

**Table 8. K4 Address Jumpers on the MCB V2.1**

Address Setup via Jumper Setting	Step for MCB Address Setup
<p>MCB with Address "0" (D4, D5, and D6 LEDs off)</p> 	<p>For each of the three jumpers on K4,</p> <p>Open/floating → address bit = "0" Short → address bit = "1"</p> <p>Follow these steps for setting up an MCB address:</p> <ul style="list-style-type: none"> <li>Power off the MCB.</li> <li>Set up the new MCB address. See address examples in the left column for address bits "0," "1," and "2," which allow 8 possible unique MCB addresses in binary format.</li> <li>Power on MCB.</li> <li>Check the MCB address displayed on LEDs D4, D5, and D6.</li> </ul>
<p>MCB with Address "1" (D4 LED on)</p> 	<p><u>Note:</u> The MCB reads the address at initialization after power-up and therefore activates a new address setting only after a reset or power-up. The D3 LED for the state of the microcontroller remains on if the "Board Supply" power supply at KL1 is within the range of 8 to 16 VDC.</p>
<p>MCB with Address "2" (D5 LED on)</p>  <p>Jumper Setup for MCB Address</p> <p>MCB Address: D6 = Bit 2 D5 = Bit 1 D4 = Bit 0</p> <p>D3 Microcontroller Status LED</p>	

## 6. Communication Settings

The SSC MCB V2.1 contains a microcontroller with an internal 8-bit RISC processor. The serial communication between the MCB microcontroller and the SSC CB microcontroller is handled their standard UART interfaces. All functions of the MCB can be controlled by the SSC CB. In the simplest case, a terminal program (e.g., Hyper Terminal) with the following configuration can communicate via the corresponding virtual COM port using defined commands with the hardware.

Baud rate: 19200  
 Data bits: 8  
 Stop bits: 1  
 Parity: None

The Evaluation Software includes a small terminal program, adapted to the communication parameters of the SSC CB. The communication procedures of the various software modules are based on this model. The possible commands can be classified as READ, WRITE, or SPECIAL commands. Every command sent to the hardware will be answered by a "value" or an error code. For the DUT's typical data structures, refer to the *Functional Description* for the specific IDT SSC DUT, which is available on the product's page on IDT's web site [www.IDT.com](http://www.IDT.com).

### 6.1 Commands for the Mass Calibration Board

The known command set of the SSC CB is valid for the MCB as described in the *SSC Communication Board Datasheet*. There is an additional command "X." This command "X" does not affect the SSC CB directly; however, a monitoring of the MCB's ACKNOWLEDGE signal is initialized. The SSC CB forwards these ACKNOWLEDGE signals or an error code (in the event of a NO ACKNOWLEDGE) to the user's computer. A command can be extended by the MCB's pre-command segment.

Syntax of this pre-command segment:

**Xa.....:** The command starts with "X" and is finished with ":"  
 "a" is the ID of the MCB to be addressed.

There are different types of syntax:

- Standard "Port Set/Read" commands are running on the MCB itself.  
 (The CB forwards the MCB's ACKNOWLEDGE signal to the user's computer only!)  
 Example: **X1PS\_A01:X** → Port **A0** of the MCB with address "**1**" is Set to "**1**"
- Control of the logic sensor Channels (**1** to **24**)  
 ("C" symbolizes "Channel" and "\_" is a wild card character.)  
 (Channel "**99**" addresses the entire **24** sensor Channels simultaneously.)  
 Example: **X4C\_221:X** → Channel **22** of the MCB with address "**4**" is set to "**1**"  
 (= power supply of this Channel is turned ON by a power transistor.)  
 Example: **X9C\_990:X** → *all* (**99**) Channels of *all* MCBs (**9**) are set to "**0**"  
 (= power supply to all Channels is turned OFF with this command.)

3. Activation of communication Channels

The following commands control the logic on the dual DUT control circuit:

**X1CZ1:X** → activates (= "1") OWI communication via the MCB with address "1"

**X9CA1:X** → activates (= "1") Analog Channel of all connected MCBs (address "9" = all)

**X1CZ0:X** → deactivates (= "0") OWI communication via the MCB with address "1"

The next commands control the signal flow between the CB's microcontroller and the DUT:

**X9PS\_D21:X** → set control signal for multiplexer (IC5 on Central Control Unit)

**X9PS\_D30:X** → set second control signal (selects OWI interface on all MCBs (9))

4. Simultaneous commands for the SSC CB and MCB

Example: **X1C\_241:OW\_7800172** → activates (= "1") Channel 24 of the MCB with address "1"

(power ON); 5ms later (fixed) the command "OW\_7800172" is run by the SSC CB (via this command, the OWI interface of the DUT is initialized and the DUT is set into "Command Mode")

5. Special commands for MCB

**X1V:X** → read the firmware's Version string for the MCB with address "1"

## 7. Application Recommendations

The MCB hardware controls the power supply of the connected DUTs, which are powered via pin 1 on the DUT connectors (VDDA). The DUTs can be supplied by the internally generated 5 VDC supply voltage if the DUT's supply voltage is 5V.

The option to supply the DUTs via the MCB's screw terminal KL2 ("VDD\_DUT") or K18 must be used if the DUT's supply voltage differs from the MCB's supply voltage. This potential is limited to a maximum of 0.5V more than the MCB's supply voltage; i.e., 5.5V.

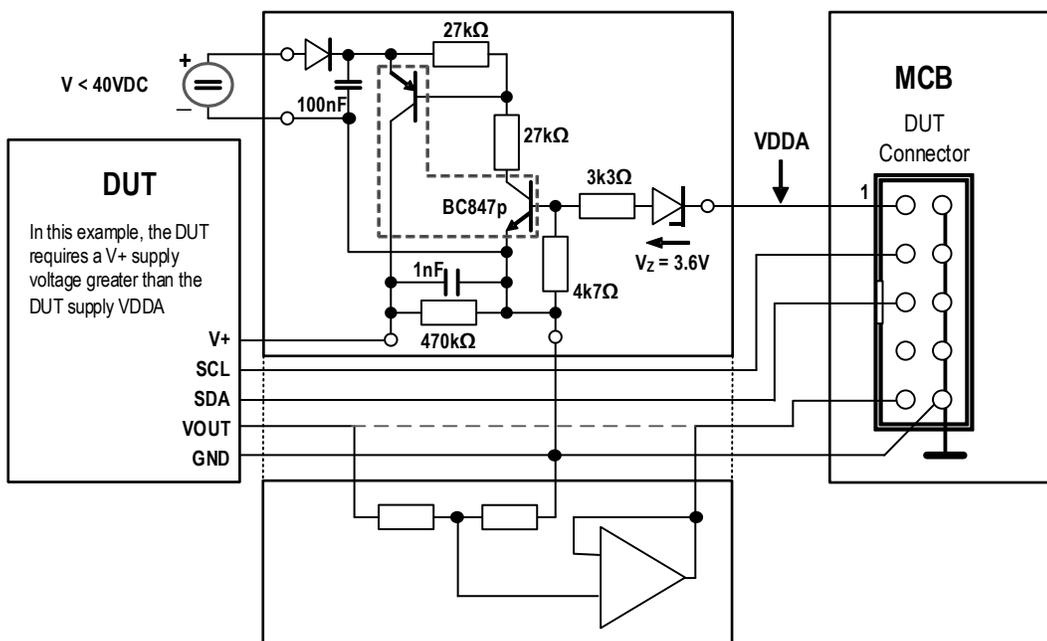
### 7.1 DUT Supply Voltages Higher than the MCB's Supply Voltage

Using the circuit shown in Figure 6, a DUT supply > 5.5VDC can be used without restrictions regarding the mass calibration functionalities of the MCS. With this adaptation board, the internal VDDA voltage of the DUT is limited to a maximum of 5VDC (refer to the datasheet for the SSC DUT regarding voltage regulator adjustment, if applicable).

The following adjustments must be done on the MCB:

- Put a jumper shunt on K14 ("VDD\_DUT") set to "int(5P)."
- Put a jumper shunt on K23 ("BUS Power") set to "+5V."

**Figure 6. DUT Connection Circuitry for High Voltage DUT Supply**



IDT offers the MCS Power Switch Board V1.0 module for the ZSC31010 and ZSC31050 DUTs, which fits in the terminals of the MCB and allows supplying the DUTs with voltages up to 40VDC. For additional information, contact IDT Sales. For order information, refer to the *SSC Mass Calibration System Feature Sheet*.

A voltage divider and buffer for the DUT's output voltage (VOUT) must be used when using the MCB's analog output voltage multiplexing function if the maximum output voltage of the DUT is greater than 5V (e.g., 0 to 10V output). This divides the output signal so that it is in a range smaller than 5V.

Note that in this case, the communication potentials are pulled high (open drain!) using the VDDA supply potential.

## 7.2 DUT Supply Voltages Lower than the MCB's Supply Voltage

The MCS also supports DUT supply voltages lower than the supply voltage for the MCB and SSC CB. The MCB and SSC are supplied internally with 5V.

The following adjustments must be done at the MCB:

- Put a jumper shunt on K14 ("VDD\_DUT") set to "extern."
- Put a jumper shunt on K23 ("BUS Power") set to "I2C Power."
- Supply the DUTs with required supply voltage via connector "VDD\_DUT" (KL2).
- Connect the I2C communication line supply to the same potential/supply voltage via the connector "I2C Power" (KL3).

## 7.3 4 to 20mA Current Loop Application

The MCB hardware also supports the current loop application. The primary difference between current loop applications and other applications is measurement of the loop current. For calibration of the loop, normal parallel connection of all DUTs to one supply source is not applicable because the coupling between the DUTs would invalidate the loop current measurement.

**Calibration of current-loop-application DUTs requires an independent and potential-free supply source for every DUT!**

The following adjustments must be done on the MCB:

- Put a jumper shunt on K14 ("VDD\_DUT") set to "int(5P)"
- Put a jumper shunt on K23 ("BUS Power") set to "+5V"

## 7.4 DUT Output Voltage Measurement using MCB

The MCB contains a multiplexer for connecting the output potential VOUT of the selected DUT to a connection terminal and the SSC CB's on-board ADC (the 10-bit ADC of the ATMEGA32).

Note: In general, the DUT's output potential to be measured (VOUT) is never higher than the MCB's supply voltage (5V).

The following commands allow measurement of the output voltage. The command always contains an identifier for the selected MCB (MCB address) and the DUT to be accessed:

- **\$:** MCB address = "0" to "7" or "9" for a broadcast command
- **##:** DUT number (2 characters) = "01" to "24" or "99" for a broadcast command

Example conditions for Table 9:

- All DUTs are calibrated and programmed completely.
- No communication. See the *SSC Communication Board Command Syntax* for an example with communication.

**Table 9. Commands for Analog Voltage Measurement**

CMD#	Command	Description
1	x9ca1:x	Enable analog output measurement for all connected MCBs.
2	x9cp1:x	Power on all DUTs on all MCBs.
3	x9c_990:x	Switch off all open communication/measurement channels on all MCBs.
	Loop	Loop from first DUT on first MCB to last DUT on last MCB.
4	X\$c_##1:x	Open a measurement channel for DUT number "##" at MCB "\$."
	=>	The output signal of DUT number "##" at MCB "\$" can be measured now using the SSC CB's ADC or with a digital multimeter connected at KL4 or K6.

CMD#	Command	Description
5	a_1RRR	Use the SSC CB's ADC for analog output voltage measurement.
	=>	Delivers averaged value of "R" samples with R = 0 to 255, 3 characters required. The result is referenced and ratiometric to the SSC CB's VDDA. 10-bit resolution: minimum is 0000 <sub>HEX</sub> ; the maximum is 03FF <sub>HEX</sub> .
6	x9c_990:x	Close all open communication/measurement channels on all MCBs.
	Loop end	
7	x9ca0:x	Disable analog output measurement for all connected MCBs.
8	x9cp0:x	Power off all DUTs at all MCBs.

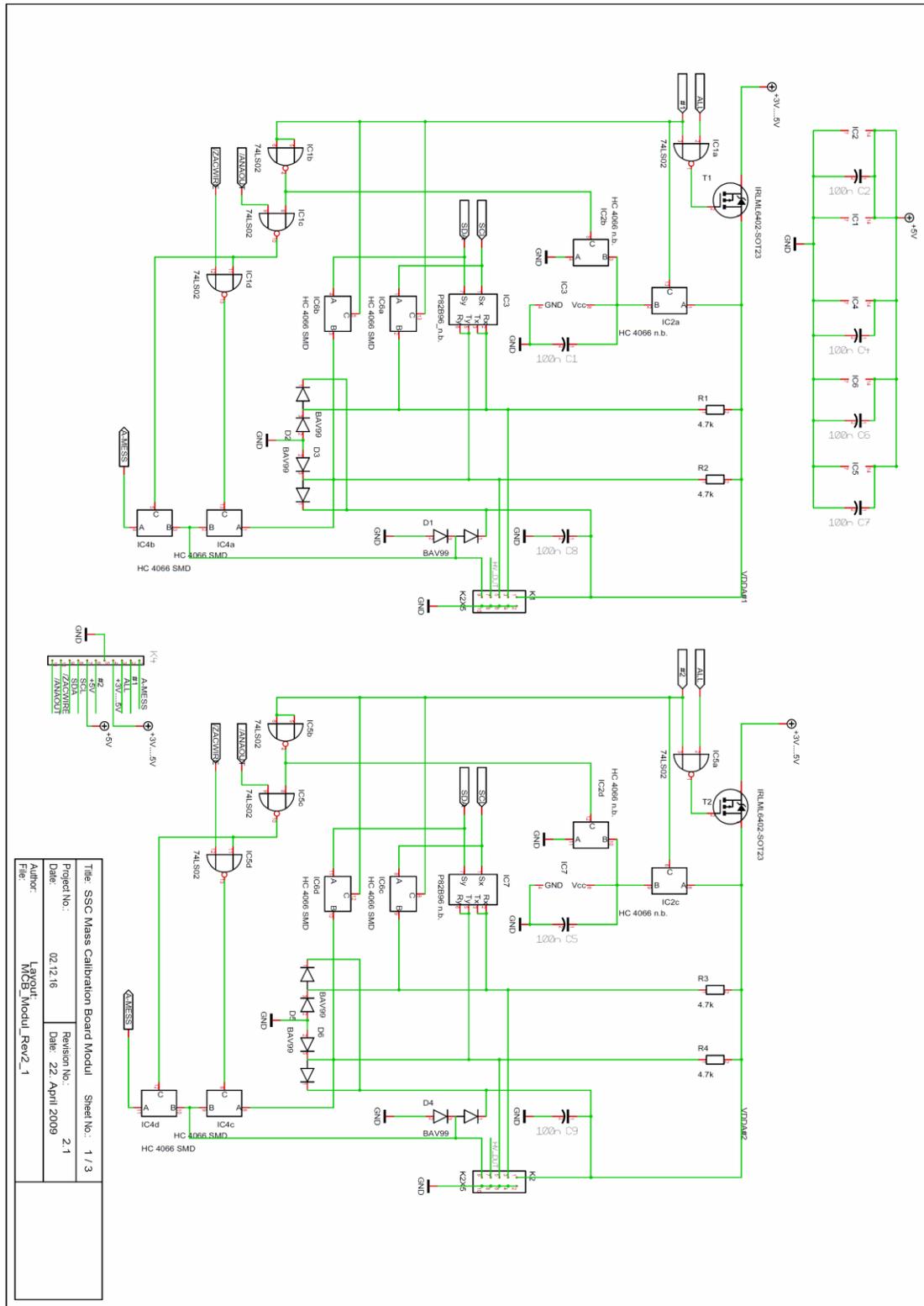
#### Recommendations for Commands:

- X\$c\_##1:x Only one DUT **on one MCB** can be active at a time when using an **external digital multimeter on every MCB** via KL4 or K6 => use x\$ps\_G0\*:x and x\$ps\_F4\*:x, "9" for "\$" is allowed.
- X\$c\_##1:x Only one DUT **on all MCBs** can be active at a time when using only one external digital multimeter or the CB's ADC => use X\$ca\*:x, "9" for "\$" is permitted.
- X\$ca\*:x Processing of x\$ps\_F3\*:x, x\$ps\_F4\*:x and x\$ps\_G0\*:x
- x\$ps\_G0\*:x Activate/deactivate the MCB's analog output mode (ATMEGA port G0).  
\* = 0 or 1 "1" for activation of the port and "0" for deactivation of the port.
- x\$ps\_F3\*:x Connect/disconnect the DUT's analog output to the SSC CB's 10-bit ADC (ATMEGA port F3).
- x\$ps\_F4\*:x Connect/disconnect the DUT's analog output to KL4 and K6 (ATMEGA port F4).

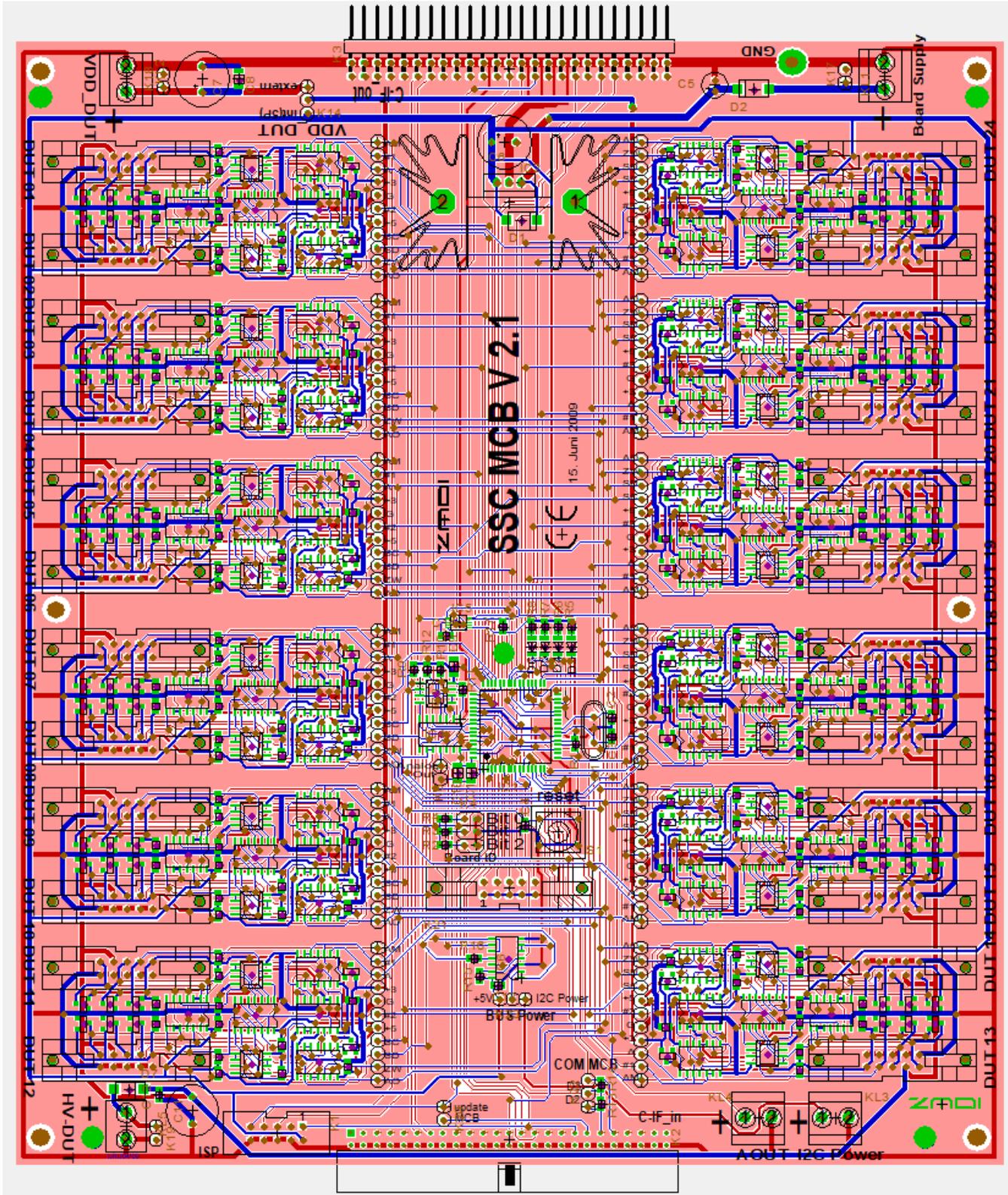


**Figure 8. Schematic – Dual DUT Control Circuit**

Note: All ICs in this Dual DUT Control Circuit schematic have the prefix “M\_” so that these ICs can be distinguished from ICs in the Central Control Unit.



## 9. Board Layout



## 10. Glossary

Term	Description
CB	Communication Board
DUT	Device Under Test
HV	High Voltage
MCB	Mass Calibration Board
MCR	Mass Calibration Reference Board
MCS	Mass Calibration System
OWI	One-Wire-Interface
SSC	Sensor Signal Conditioner
UART	Universal Asynchronous Receiver/Transmitter

## 11. Ordering Information

Orderable Part Number	Description
SSCMASSCALIBDV2P1	SSC Mass Calibration Board V2.1

## 12. Revision History

Revision Date	Description of Change
April 18, 2018	<ul style="list-style-type: none"> <li>▪ Revision for Appendix A.</li> <li>▪ Updates for template.</li> <li>▪ Update for board images.</li> <li>▪ Addition of order code table.</li> <li>▪ Minor edits</li> </ul>
April 1, 2016	Changed to IDT branding. The revision is now the release date.
August 6, 2014 (Rev. 2.00)	Updated for SSC CB revision 4.1. Document referenced to all supported SSCs. Updates for imagery for cover and headers. Updates for contacts.
December 6, 2010 (Rev. 1.04)	Added details to section 4.5.1. Added section 4.3.
July 30, 2010 (Rev. 1.03)	First release after format update. Revision of product name to ZSC31xxx / ZSSC3xxx.
September 9, 2009 (Rev. 1.02)	Technical revision. Added pictures for descriptions of jumper settings and screw terminals. Removal of "Interaction with former MCBs" section to a separate document.
July 3, 2009 (Rev. 1.01)	Reorganization of document. Added "Application Hints" from Rev. 0.09. Added sections 4.1, 4.3, 5.1.2, 4.5.1, and 5.1.1.
June 15, 2009 (Rev. 1.00)	First release after format update. Update for MCB V2.1.

## Appendix A: Examples of Measurement

This section shows some measurement examples. These examples are made with a ZSC31050 connected as DUT1 to MCB with address 0. The commands from section 6.1 can be used for setup and communication.

### I2C Communication

```
x0c_990:x          'set signal ALL = 0 (= inactive)
x0cz0:x           'activate I2C communication
x0c_011:x         'activate channel 1
iw_7800172
iw_7800102        'start cycle
                  'wait 0.03 settling time
{
                  ir_78002    'read 2 Bytes from address 78
}
x0c_010:x         'deactivate channel 1
```

### OWI Communication

```
x0cz1:x          'activate OWI communication
ps_a01           'set port a0 to "1" (OWI line = "high")
x0c_011:ow_7800172 'activate channel 1 and transmit command
                  "ow_7800172" with a delay of 5ms
ow_78003970134   'configures RAM to "OWI forever"
                  functionality regarding sensor signal output
ow_7800102       'start cyclic measurement
{
  or_78002        'read 2 bytes from address 78
}
x0c_010:x         'deactivate channel 1
```

### Analog Voltage Output

```
x0ca1:x          'activate analog channel
x0c_011:x         'activate channel 1
                  'wait 0.05s settling time for analog value
a_1010           'read analog value
x0c_010:x         'deactivate channel 1
```