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Interfacing ICmic Serial DAC to SPI™/QSPI™ and MICROWIRE™ Serial Interface

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There are two types of serial communication interface standards. One is synchronous interface and the other one is asynchronous interface. The system is called synchronous if it has a dedicated clock signal to control the data. In a synchronous system, a master device usually outputs a clock signal that is received by a slave device to receive and transmit data in synch while in asynchronous interfaces the system embeds the clock information into the data stream.

Synchronous interfaces were designed mainly to connect peripheral devices on the same printed circuit board which has relatively short distances of electrical paths (usually shorter than 1 meter), while the asynchronous interfaces are usually intended for long distance communication.

SPI™/QSPI™ and MICROWIRE™ are among the most common types of serial synchronous interfaces usually used in the industry today. SPI™/QSPI™ was developed by Motorola Semiconductor and MICROWIRE™ was developed by National Semiconductor.

To allow easy interfacing ICmic has designed serial DACs that are compatible to both SPI/QSPI serial interface and MICROWIRE serial interface.

This application note is intended to give a brief introduction on how to connect the ICmic serial DACs with other devices using SPI/QSPI and MICROWIRE as serial interface standard. General information about SPI/QSPI and MICROWIRE serial interface standard is provided before explaining the usage of these interfaces with ICmic serial DAC.

This application note uses ICM7362 - a Dual 12-Bit Voltage Output Serial Interface DAC with Gain of 2 as a slave. However, the information provided is also applicable for other ICmic serial DAC using these interface standards.

MICROWIRE™ Interface

MICROWIRE is a simple three-wire serial communications interface. Built into COPS™, this standardized protocol handles serial communications between controller and peripheral devices [1]. This standard was developed by National Semiconductor and is widely used by its devices. In typical applications of MICROWIRE, usually the controller or the master is a Microprocessor and the slaves can be either memory or Input/Output units. MICROWIRE has a minimum of 3 pins to be able to interface; those pins are SO (Serial Out), SI (Serial In) and SK (Serial Clock), while the CS (Chip Select) pin is optional.

However, the CS (Chip Select) pin must be used in multi slave mode. Reference [1] presents the software routines that are written for 16-bit transmissions and is expandable up to 64-bit transmissions for the COP420 Microprocessor. The users can select the appropriate one for their applications.

SPI/QSPI Signals	MICROWIRE Signals
SCK- Serial Shift Clock	SK – Serial Shift Clock
MOSI - Master Out Slave In	SO – Serial Out
MISO – Master In Slave Out	SI – Serial In
SS – Slave Select	CS – Chip Select

Table 1. SPI/QSPI and MICROWIRE standard pins

SPI™/QSPI™ Interface

The Serial Peripheral Interface (SPI) standard was developed by Motorola and is used by its serial Microprocessors. The QSPI is fully compatible with SPI systems found on other Motorola products [3].

As MICROWIRE, SPI/QSPI is also full-duplex, where data can be transmitted and received at both direction between master and slave.
SPI/QSPI have a minimum of 3 wire or 3 pin connection, Those pins are MOSI (Master Out Slave In), MISO (Master In Slave Out) and SCK (Serial Clock) while SS (Slave Chip Select) pin is not always used. In case there is only one slave in the system, the SS pin can be enabled at all time.

But if there are multiple slaves in the system, the SS pin must be used to avoid any interference among slaves during the transfer of data.

Each slave in multi slaves mode should have their own SS signal which means if there are n

slaves, it will have (3+n)-wire serial busses or connections. As depicted in Figure 1, there is a multiple slave mode system with microcontroller as a master. It has 3 slaves, so it needs 6-wires serial buses or connections.
Those SPI/QSPI connections in Figure 1 are applicable also for MICROWIRE standard interface, MOSI can be replaced by SO, MISO can be replaced by SI, SCK can be replaced by SK and SS can be replaced by CS.
Please refer to Table 1 for the comparison of each pin of SPI/QSPI and MICROWIRE. As seen in Table 1, the related pins of SPI/QSPI and MICROWIRE have the same function.

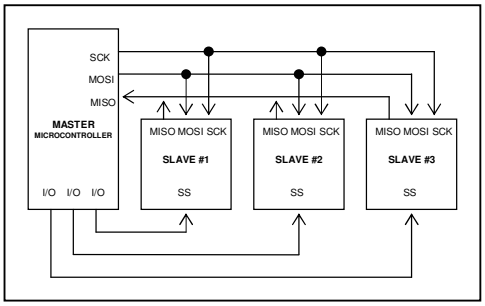

Figure 1. A multiple slave system with a microcontroller as a master. It needs 6-wires serial busses or connections to control 3 slaves.

ICM7362 – ICmic Dual 12-bit DAC

ICM7362 is a Dual 12-Bit Voltage Output Serial Interface DAC with an output gain of 2. This DAC is one of the serial devices provided by ICmic that fully comply with SPI™/QSPI™ and MICROWIRE™ interface standards.

This DAC has 2 outputs and has an output gain of 2. To set its output, this DAC has to be provided with serial data and other appropriate control signals. There are 4 pins for its serial interface, which are SDI (Serial Data In), SDO (Serial Data Out), SCK (Serial Clock) and CS (Chip Select).

Interfacing to SPI/QSPI and MICROWIRE

Care has to be taken on the Chip Select (CS) pin of this DAC during operation. This pin is not only used to select the chip; it is also used to trigger the DAC to update its output with new available data that is fed by the SDI pin on the clock signal of SCK pin. So this CS pin can not be enabled at all times by simply connecting it to ground in case of a single slave as in MICROWIRE and SPI. This pin should be controlled by an I/O pin in all circumstances.

Thus, the CS pin is not optional as allowed by SPI/QSPI and MICROWIRE standards. Connection of this pin is needed since the state change is necessary on this pin to update the DAC output. If there is no change in the state of this pin, the DAC output will not be updated. Please refer to Figure 2 for an example of this.

This figure shows that the DAC output will be updated after the 16th cycle of the serial clock while the state of this pin should be changed from logic low to logic high. Also note that before the 1st clock cycle, this pin should be changed from logic high to logic low to allow the clock signal to start its count. The clock signal is internally disabled while the CS signal is high.
In MICROWIRE standard, the CS (Chip Select) pin is controlled by I/O, and also the SS pin in SPI/QSPI standard. Figure 1 shows how the SS pins of slaves are connected and controlled by I/O pin of master.

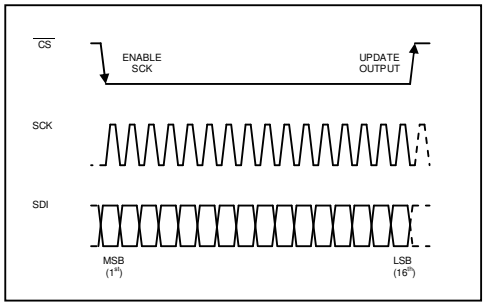

Figure 2. The Chip Select pin is set to be high from low to update the DAC output after the 16th Clock.

Take a note, the connection between the SDO (Serial Data Out) pin of DAC with SI (Serial Input) pin of MICROWIRE or MISO (Master In Slave Out) pin of SPI/QSPI is optional. It will be used in the application where the data read back is needed. But the other three connections are absolutely necessary to use the DAC properly.

In the two figures below, not all pins are shown. It shows only the corresponding pins to get a better understanding of serial interfacing standard while other pins are connected to other peripherals as needed. This connection is also applicable for other ICmic serial DACs supporting these particular serial interfaces.

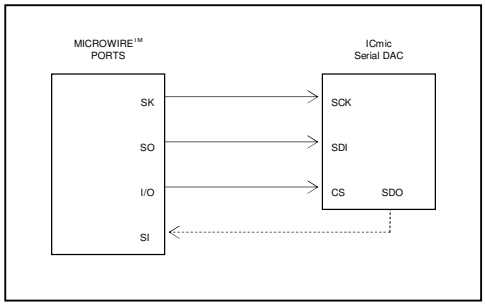

Figure 3. Typical MICROWIRE – Serial DAC connections. SDO (Serial Data Out) pin of DAC in connection are optional, while other input pins are connected as normal.

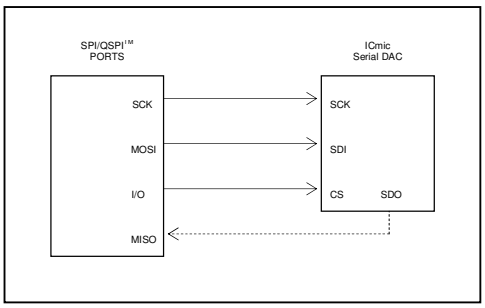

Figure 4. Typical SPI/QSPI – Serial DAC connections. SDO (Serial Data Out) pin of DAC in connection are optional, while other input pins are connected as normal.

Conclusion

Interfacing between ICmic serial DAC with either SPI™/QSPI™ serial interface or MICROWIRE™ serial interface standard can be done easily as it has been introduced by this application note.

Care has to be taken on the Chip Select (CS) pin of serial DAC during operation and while connecting to a serial interface standard. This pin is not only used to select the DAC but is also used to trigger the DAC to update its output. Therefore, it is incorrect to simply connect this pin to ground at all times during its operation.

SPI™ and QSPI™ are trademarks of Motorola Semiconductor Corporation.

MICROWIRE™ is a trademark of National Semiconductor Corporation.

References

[1] Abdul Aleaf, *Application Note 452 - Microwire™ Serial Interface*. National Semiconductor, Arlington, Texas, USA, 1992.

[2] Motorola. *M68HC16Z1 - Technical Data 16-Bit- Microcontroller - Technical Summary Revision 3.* Phoenix, Arizona, USA.1996.

[3] Motorola. *M68HC11 Microcontrollers-Reference Manuals. Revision 6.* Phoenix, Arizona, USA. 2002.

[4] IC Microsystems Sdn. Bhd. Malaysia, *ICM7362/7342/7322 - Dual 12/10/8-Bit Voltage Output DACs - Serial Interface,* Malaysia, 2003.

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