TMC 363 – DATA SHEET

transformerless VFD Power Supply IC
with optional control via 2 wire serial Interface

TRINAMIC
MOTION CONTROL

TRINAMIC® Motion Control GmbH & Co. KG
Sternstraße 67
D – 20357 Hamburg
GERMANY

T +49 - (0) 40 - 51 48 06 - 0
F +49 - (0) 40 - 51 48 06 - 60
WWW.TRINAMIC.COM
INFO@TRINAMIC.COM

Features

The TMC363 is a filament driver for Vacuum Fluorescent Displays (VFD), replacing the commonly used expensive high current transformers. It drives the filament using a sine wave, eliminating the high energy square wave chopper EMV impulses and EMV radiation. This leads to a smarter and much lighter and inexpensive solution. It is realized in a HVCMOS technology combined with Low-RDS-ON high efficiency MOSFETs (pat. fi.). The TMC363 gives the choice to operate at high temperature or at high current of up to 1060 mA. Its low current consumption and high efficiency together with the miniature package make it a perfect solution for battery powered devices as well as weight and dimension critical applications. The device can be controlled by a serial interface (I²C-like) or by analog / digital input signals. Temperature and undervoltage protection is integrated.

- Outputs two sine waves with 6 bit resolution
- Two wire serial interface
- Amplitude selectable via resistor or serial interface
- Frequency and offset digitally switchable or programmable via serial interface
- Slope control programmable via single resistor
- Chopper frequency programmable via a single capacitor or external clock range 50kHz to 500kHz
- Integrated soft start
- Step up Converter for VFD Anode supply using external Power MOS (50V; 250mA at >=9V supply)
- 7V to 28.5V supply voltage (up to 38.5V as option)
- Two integrated PWM-controlled half-bridges with up to 1500mA peak output current (1060mA rms) and more than 800mA at 105°C
- Status flags for over temperature, temperature pre-warning, and undervoltage can be read out
- Low power consumption via low RDS-ON power stage
- Shutdown mode available

Life support policy

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Pinning

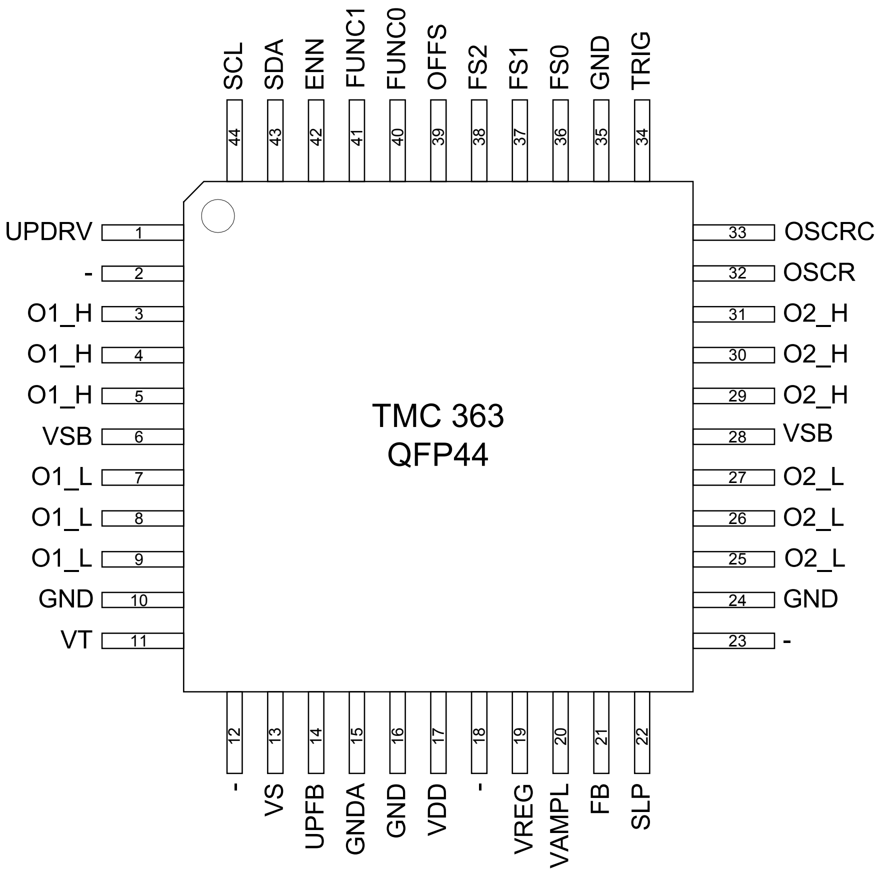

Figure 1: Pinning

Package codes

Package	Temperature range	Code/marking
PQFP 44	automotive	TMC363-PA

Table 1: package code

Application circuit / block diagram

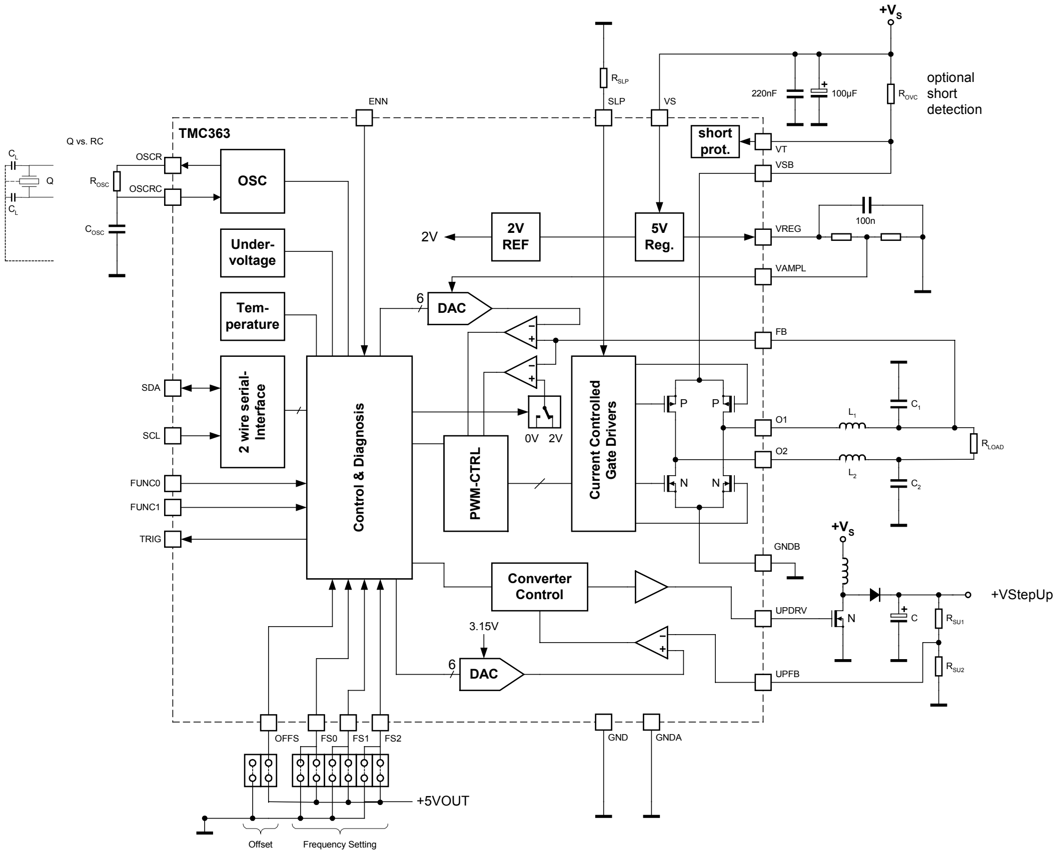

Figure 2: block diagram

Pin functions

Pin	Function	Pin	Function
VS, VSB	Supply voltage 7 – 28.5V	GNDA	Analog Ground
VREG	Output of internal 5V regulator Internally connected to Chip supply via double bond; 10mA max.	GND, GNDB	Power ground
OSCR	Oscillator Resistor Output (opt: ceramic resonator output)	OSCRC	Oscillator resistor / capacitor input or external clock input (opt: ceramic resonator input)
FB	Voltage Feedback from LC network	FUNC0, FUNC1	Function select pins
SLP	Slope control resistor	OFFS	Setting of sine wave offset
VT	Input of short to GND detector	FS0, FS1, FS2	Setting of sine wave frequency
ENN	Enable (low active), high for low power standby	VAMPL	Setting of sine wave amplitude
SCL	serial data clock	O1, O2	Output of bridge
SDA	serial data line (O.C.)	UPFB	Feedback-Voltage for Step Up-Converter. Tie to +5V if unused.
UPDRV	Driver Transistor output for Step-Up-Converter	TRIG	Trigger output

Table 2: pin functions

Filament sine wave drive

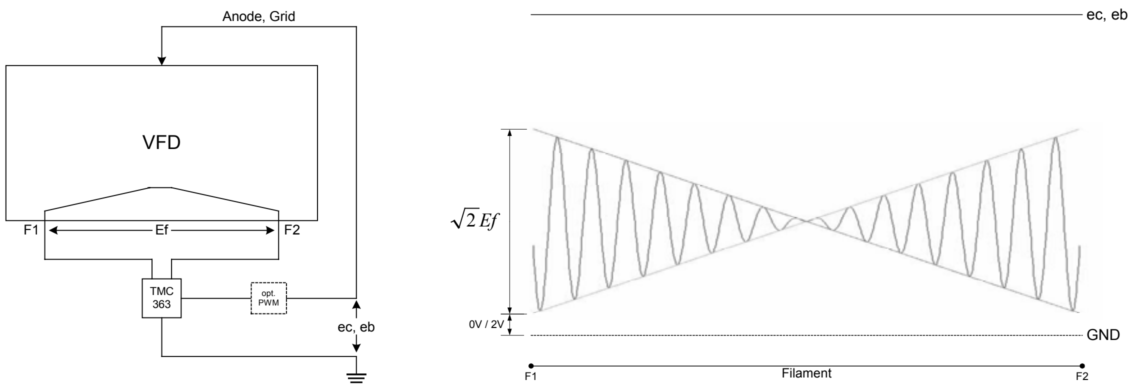

Figure 3: Filament AC Drive

The potential of the different supply voltages of VF-Displays is shown in figure 3. The filament voltage (Ef) is always higher than the ground potential of the anode and grid voltage (ec, eb) to cut off background illumination. For exemplification the voltage plan of the TMC363 is equivalent to an application with a center tap transformer including a bias voltage.

Example of use

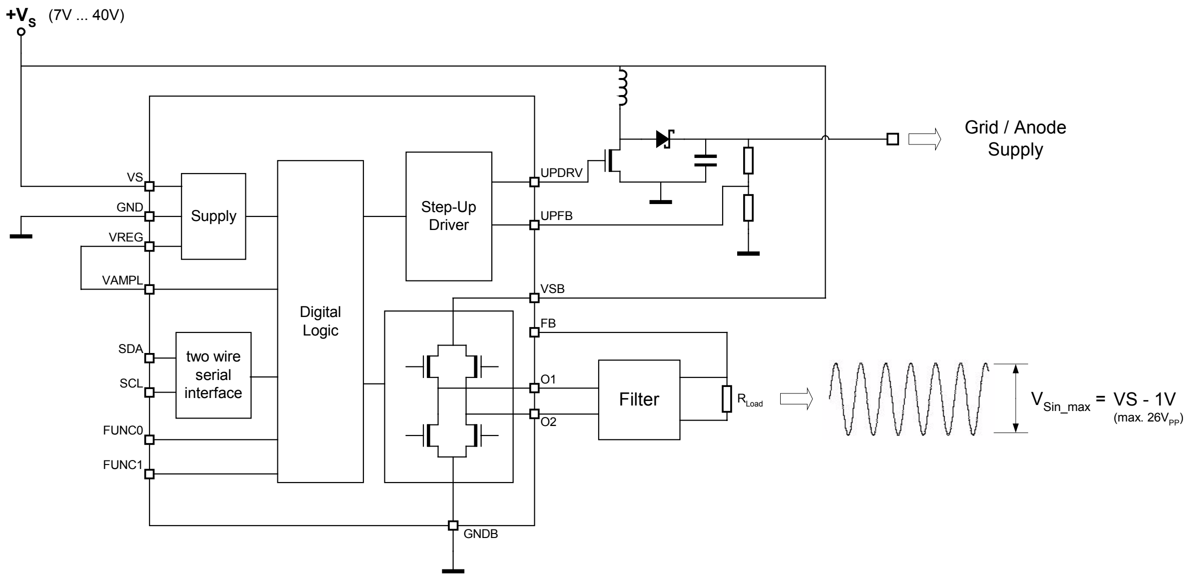

Figure 4: normal supply mode

In standard applications the TMC363 provides a sine wave which amplitude is programmable in the range of 0V up to V_S–1V. At supply voltages higher than 26V the amplitude is limited to $26V_{PP}$. The step-up voltage for the anode or grid supply is not limited to V_S. The amplitude of the step-up voltage is controlled by the external voltage divider and/or the serial interface value.

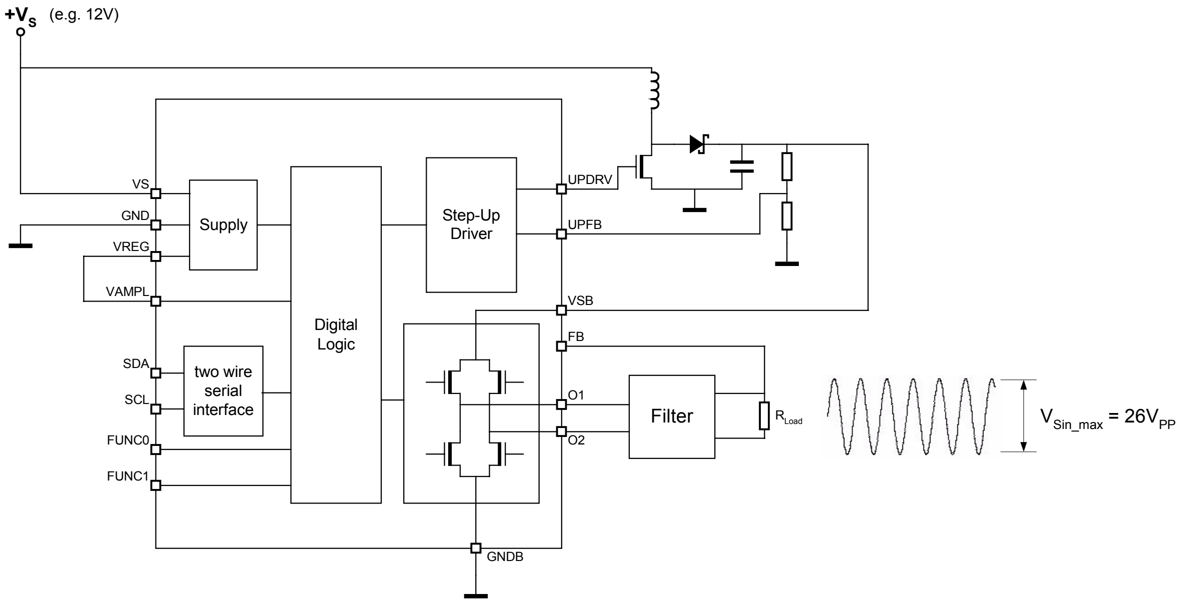

Figure 5: Boost sine wave mode

In boost mode its possible to acquire a sine wave amplitude which is higher than the supply voltage. In this case the bridge supply (V_{SB}) has to be connected to the output of the step-up converter. The sine wave amplitude is than limited to 1V below the step-up voltage but at most up to $26V_{PP}$.
Caution: The maximum bridge supply voltage is 40V (see absolut maximum ratings). A higher voltage can damage the device.

Function setting

Func1	Func0	mode
0	0	reserved (do not use)
0	1	serial interface mode
1	0	sinus wave (stand alone mode)
1	1	DC output (stand alone mode)

Table 3: function settings

The function of the TMC363 is selectable via the 'Func' pins. In serial interface mode the option between sine wave or dc voltage is selectable.

Frequency setting

The PWM oscillator frequency can be set by an external capacitor and an external resistor. The internal oscillator uses the resistor to charge / discharge the capacitor to a trip voltage of 2/3 Vcc respectively 1/3 Vcc. It can be overdriven using an external CMOS level square wave signal.

The TMC363 uses f_{OSC} / 16 as chopper frequency. This chopper frequency is used for the sine wave and the step up converter.

$$f_{chop} = \frac{f_{osc}}{16}$$

Table of frequencies when set via the pins. All values can be selected via serial interface.

f_{sin} divider	f_{sin} @ 8 MHz f_{OSC}	f_{sin} @ 6 MHz f_{OSC}	f_{sin} @ 4 MHz f_{OSC}	FS2	FS1	FS0
/ 80000	100 Hz	75 Hz	50 Hz	0	0	0
/ 20000	400 Hz	300 Hz	200 Hz	0	0	1
/ 444	18.0 kHz	13.5 kHz	9.0 kHz	0	1	0
/ 256	31.3 kHz	23.5 kHz	15.6 kHz	0	1	1
/ 186	43.0 kHz	32.3 kHz	21.5 kHz	1	0	0
/ 144	55.6 kHz	41.7 kHz	27.8 kHz	1	0	1
/ 116	69.0 kHz	51.8 kHz	34.5 kHz	1	1	0
/ 100	80.0 kHz	60.0 kHz	40.0 kHz	1	1	1

Table 4: frequency settings

The dimension of the output filter (LC-Combination) is depending on the frequency. At frequencies greater then f_{OSC}/160 the filter needs to be at least 2^{nd} order.

Oscillator

The PWM oscillator frequency can be set by an external capacitor and an external resistor. The internal oscillator charges / discharges the capacitor between the trip voltages.
Alternatively a 2.5 … 8-MHz ceramic resonator (with load capacitors C_L) can be used.
The oscillator input OSCRC can be overdriven using an external CMOS level square-wave signal.

f_{osc} typ	C_L
2.5 MHz	36 pF
4.0 MHz	22 pF
8.0 MHz	15 pF

Table 5: oscillator frequencies when using ceramic resonator

f_{osc} typ	R_{osc}	C_{osc}
2.4 MHz	kΩ	pF
3.1 MHz	kΩ	pF
4.0 MHz	kΩ	pF
5.1 MHz	kΩ	pF
8.0 MHz	kΩ	pF
8.0 MHz	kΩ	pF

Table 6: oscillator frequencies when using RC option

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{OSC}	frequency of RC-oscillator with defined R and C for 4 MHz	R= kΩ C= 22pF	tbd	4	tbd	MHz

Table 7: oscillator characteristic

Please remark, that an unnecessary high frequency leads to higher switching losses in the power transistors.

Serial interface

Communication between a host and the TMC363 takes places via the two wire bi-directional serial interface. The serial interface facilitates the alternative programming of all settings. The frequency is programmable with a resolution of 15 Bit and a range from 0 to 125kHz. The resolution of the amplitude is 6 Bit. Further the offset- and the softstart- option is selectable via the serial interface.

Output voltage swing

The output voltage setting is controlled by a resistive divider. Depending on the offset setting and on the actual load, the lower sine wave limit varies between 0 and 2V. The upper limit can be set up to 21V. The output voltage of the TMC363 is equal to:

$$V_{FB\_\max} = 4.2 \cdot V_{Ampl} \frac{n}{63}$$

whereas n is depending on the operational mode. In stand alone mode the value of n is 63. In the serial interface mode n is selectable in the range 0 to 63.

The accuracy of the filament output depends on the selected output frequency. The control logic analyze the output via a few full periods to avert output swing. At a supply voltage jump of 10% the control time of 50Hz sine wave setting amounts at most 100ms. At frequencies greater than 10kHz the control time shrinks to a value below 100µs.

Undervoltage detection

The internal circuitry starts operation, whenever the 5V supply is in its lower operation limit. Because the required supply voltage depends on the required filament voltage, the internal circuit monitors the output to determine if it can reach the filament voltage level set by the user.

Step up converter

The step up converter monitors the output voltage. Chopping frequency is fixed to 1/16 oscillator frequency. When the output voltage is below the comparator threshold, the transistor duty cycle is increased from 0/16 to 10/16 within 10 oscillator cycles. It is reduced down to zero in 10 cycles if the voltage is continuously above the threshold. The maximum duty cycle is programmable via the serial interface. The standard setting for the maximum duty cycle is 10/16 and is increasable to 12/16 for higher current request.
The output voltage is set by the voltage divider R_{SU1} and R_{SU2}.

$$V_{Step\_Up} = V_{UPFB}\left(\frac{R_{SU1}}{R_{SU2}} + 1\right)$$

The value of V_{UPFB} is fix at 3.15V. In serial interface mode this voltage is regulated by the configuration of the DAC2 parameter.

$$V_{UPFB} = 3.15V \frac{n}{63}$$

n is the value of DAC2_0 … DAC2_5.

Slope control resistor

The output-voltage slope of the full bridge outputs can be controlled to reduce noise on the power supply and on the filament and thus electromagnetic emission of the circuit. It is controlled by an external resistor at the SLP pin.

Operational range:

$$12.5k\Omega \leq R_{SLP} \leq 150k\Omega$$

Please remark, that there is a trade off between reduced electromagnetic emissions (slow slope) and high efficiency because of low dynamic losses (fast slope).

Example for slope settings

t_{SLP} typ.	R_{SLP}
30ns	KΩ
	KΩ
	KΩ
	KΩ
300ns	KΩ

Table 8: slope settings

Absolute Maximum Ratings

The maximum ratings may not be exceeded under any circumstances. 40V transistor version is assumed.

Symbol	Parameter		Min	Max	Unit
V_S	Supply voltage (core chip)			40	V
V_T	Short-to-Ground Detector Input Voltage		V_S+ 1V	V_S+0.3V	V
V_{FB}	Feedback Input Voltage		-0.3	V_S+0.3V	V
V_{BR}	Bridge voltage V_{SB}-V_{GNDB}			40	V
V_{MD}	Supply and bridge voltage / device disabled max. 20000s			tbd	V
V_{TRL}	Lower side power transistor voltage V_{O1}-$V_{GNDB,}$ V_{O1}-V_{GNDB}			40	V
V_{TRH}	Upper side power transistor voltage V_{SB}-$V_{O1,}$ V_{SB}-V_{O1}			40	V
V_{DD}	Logic supply voltage (*: internally regulated)			6(*)	V
I_{OP}	Output peak current (short pulse)			6	A
I_{OC}	Output current (continuous, one bridge)	$T_A \le 85°C$		1500	mA
		$T_A \le 105°C$		1000	
		$T_A \le 125°C$		800	
V_{ID}	Logic input voltage		-0.3	V_{DD}+0.3V	V
V_{IA}	Analog Input Voltage		-0.3	V_{DD}+0.3V	V
T_J	Junction temperature		-40	150	°C
T_{STG}	Storage temperature		-55	150	°C

Table 9: absolut maximum ratings

Electrical Characteristics

Operational Range

Symbol	Parameter	Min	Max	Unit
T_{AI}	Ambient temperature industrial (1)	-25	125	°C
T_{AA}	Ambient temperature automotive	-40	125	°C
T_J	Junction temperature	-40	140	°C
V_S	Bridge supply voltage (2)	7	38.5	V
f_{CLK}	Oscillator clock frequency	0	8	MHz
f_{Chop}	Chopper clock frequency		500	kHz
R_{SLP}	Slope control resistor	12.5	150	KΩ

Table 10: operational range

(1) The circuit can be operated up to 140°C, but output power derates.
(2) The maximum operating supply voltage is reduced from 40V to 38.5V with inductive loads, because inductive loads increase the output voltage above / below the supply voltage rail in fast decay and change of polarity situations.

DC Characteristics

DC characteristics contain the spread of values guaranteed within the specified supply voltage and temperature range unless otherwise specified. Typical characteristics represent the average value of all parts.
Junction temperature: T_J = -40°C … 150°C,
Bridge supply voltage : V_S = 7 V … 38.5 V
(unless otherwise specified)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{OUT,Sink}$	R_{DSON} of sink-transistor	T_A = 25°C $V_S \geq$ 8V		0.10	0.12	Ω
$R_{OUT,Source}$	R_{DSON} of source-transistor	T_A = 25°C $V_S \geq$ 8V		0.20	0.24	Ω
$R_{OUT,Sink}$	R_{DSON} of sink-transistor max.	T_J =150°C $V_S \geq$ 8V		0.17	0.20	Ω
$R_{OUT,Source}$	R_{DSON} of source-transistor max.	T_J =150°C $V_S \geq$ 8V		0.34	0.41	Ω
V_{DIO}	Diode forward voltages of O_{xx} MOSFET diodes	T_J = 25°C I_{OXX} = 1.05A		0.82	1.10	V
V_{IH}	High input voltage (all digital inputs)		2.2		VCC + 0.3 V	V
V_{IL}	Low input voltage (all digital inputs)		-0.3		0.7	V
V_{IHYS}	Input voltage hysteresis (all digital inputs)		100	250	500	mV
V_{OH}	High output voltage (output SDO)	$-I_{OH}$ = 1mA	VCC – 0.6	VCC – 0.2	VCC	V
V_{OL}	Low output voltage (output SDO)	I_{OL} = 1mA	0	0.2	0.4	V
V_{UPFB}	Step up feedback voltage			3.15	3.32	V
$-I_{ISL}$	Low input current (all digital inputs)	V_I = 0 V_{CC} = 3.3V V_{CC} = 5.0V	2	 10 25	70	µA µA µA
$-I_{IEL}$	Low input current (input ENN)	V_I = 0 V_{CC} = 3.3V V_{CC} = 5.0V	10	 20 30	50	µA µA µA

Table 11: dc characteristics

Thermal Protection

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T_{JOT}	Thermal shutdown		145	150	155	°C
T_{JOTHYS}	Thermal hysteresis			10		°C
T_{JWT}	Prewarning temperature		135	140	145	°C

Table 12: thermal characteristics

Two-Wire Serial Interface

Physical Layer

Both SDA and SCL lines are connected to positive supply voltage via a current source or pull-up resistor (Figure 6: Physical Layer). When there is no traffic on the bus both lines are high. Analog glitch filters are implemented to suppress spikes with a length up to 50 ns.

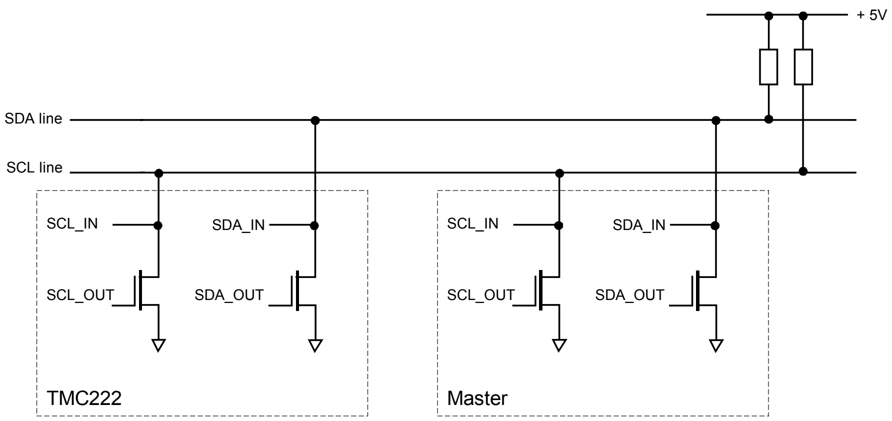

Figure 6: Physical Layer

Communication on Two Wire Serial Bus Interface

Each datagram starts with an Start condition and ends with an Stop condition. Both conditions are unique and cannot confused with data. A high to low transition on the SDA line while SCL is high indicates a Start condition. A low to high transition on the SDA line while SCL is high defines a Stop condition. (Figure 7: Start / Stop Conditions)

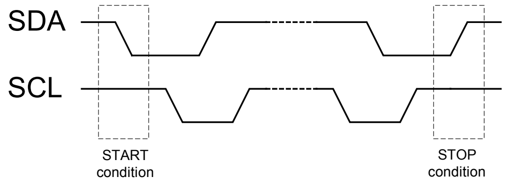

Figure 7: Start / Stop Conditions

The SCL clock is always generated by the master. On every rising transition of the SCL line the data on SDA is valid. Data on SDA line is only allowed to change as long as SCL is low. (Figure 8: Bit transfer on Two Wire Serial Bus Interface)

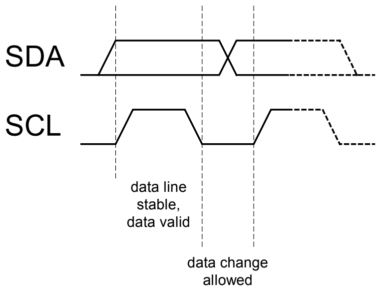

Figure 8: Bit transfer on Two Wire Serial Bus Interface

Every byte put on the SDA line must have a length of 8 bits, where the most significant bit (MSB) is transferred first. The number of bytes that can be transmitted to the TCM363 is restricted to 4 bytes. Each byte is followed by an acknowledge bit, which is issued by the receiving node. (Figure 9: Data Transfer on Two Wire Serial Bus Interface)

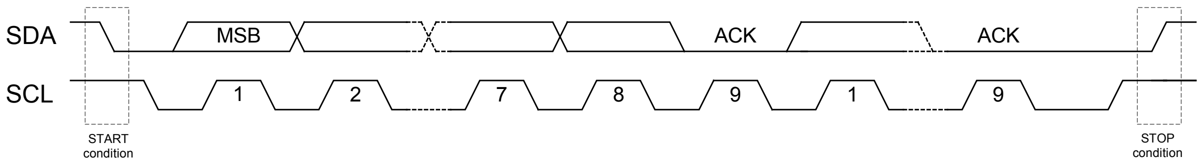

Figure 9: Data Transfer on Two Wire Serial Bus Interface

Physical Address of the circuit

The circuit must be provided with a physical address in order to discriminate this circuit from other ones on the serial bus (pins SDA and SCK). This address is coded on 7 bits (1 bits is hardwired to '1' and 2 bits are hardwired to '0'), yielding the theoretical possibility of 16 different circuits on the same bus. It is a combination of the 4 hardwired address bits (pins OFFS, FS[2-0]). (Figure 10: Two Wire Serial Interface - Physical Address)
The TCM363 supports a "general call" address. Therefore the circuit is addressable with either the physical slave or with address "000 0000".

AD6	AD5	AD4	AD3	AD2	AD1	AD0	Physical address
'1'	'0'	'0'	OFFS	FS2	FS1	FS0	Hardwired Bit (connect to 0 or 1)

Figure 10: Two Wire Serial Interface - Physical Address

Write data to TMC363

A complete datagram consists of the following: a Start condition, 5 data bytes and a stop condition. Each data byte is followed by an acknowledge bit. The acknowledge bit is used to signal the transmitter of the data byte the correct reception of the data, in this case the TMC363 pulls the SDA line to zero. (Figure 11: Two Wire Serial Interface - Writing Data to Slave).
The first data byte consists of the slave address (7 bit) and a read/write bit ('0' = write, '1' = read). The other 4 bytes contains the configuration settings of the TMC363.
The TMC363 reads the incoming data at SDA with every rising edge on the SCL line. To finish the transmission the master has to transmit a Stop condition.

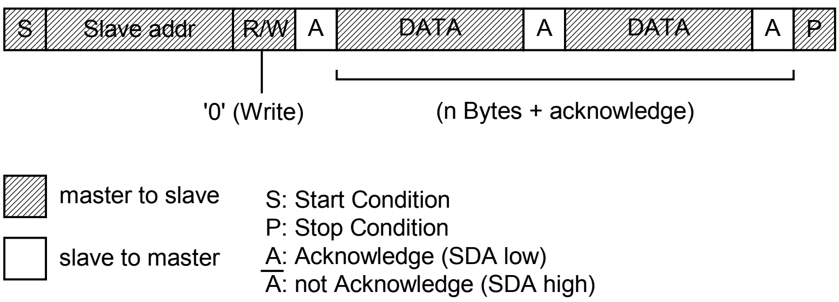

Figure 11: Two Wire Serial Interface - Writing Data to Slave

Read data from TMC363

When reading data from a slave only one datagram is needed. The datagram consists of one data byte that consists of the slave address (7 bit) and the read bit ('1').
Then the master can read the data byte on the SDA line with every rising edge on the SCL line. After the byte of data the master has to acknowledge correct data reception by pulling SDA to zero. The last byte is not to acknowledge by the master and therefore the slave knows the end of transmission. (Figure 12: Two Wire Serial Interface - Read Data from Slave)

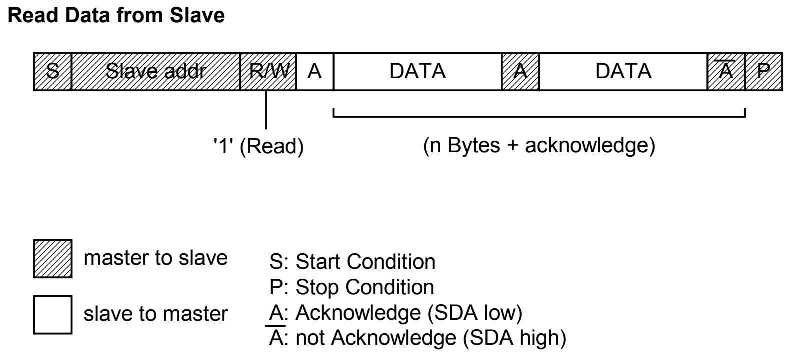

Figure 12: Two Wire Serial Interface - Read Data from Slave

Timing characteristics of the serial interface

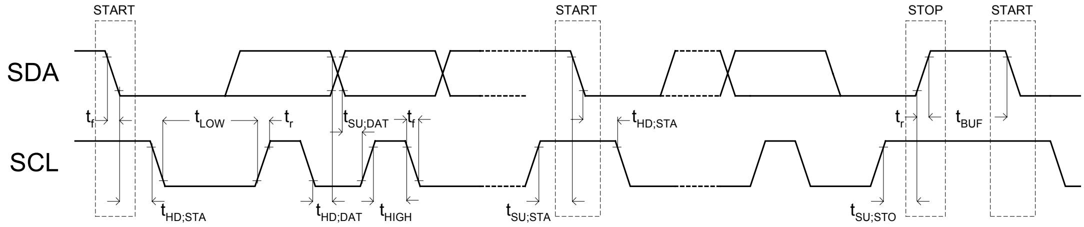

Figure 13: Definition of Timing

Parameter	Symbol	SCL Clk frequency <= 100KHz		SCL Clk frequency <= 350KHz		Unit
		Min.	**Max.**	**Min.**	**Max.**	
Low level input voltage: Fixed input levels	V_{IL}	-0.5 (1)	1.5	-0.5 (1)	$0.3V_{DD}$	V
High level input voltage: Fixed input levels	V_{IH}	3.0	(2)	$0.7V_{DD}$	(2)	V
Pulse width of spikes which must be suppressed by the input filter	t_{SP}	n/a	n/a	50	50	Ns
Capacitance for each I/O pin	C_i	-	10	-	10	pF

Table 13: Two Wire Serial Interface - Characteristics of the SDA and SCL I/O Stages

Notes
(1): If Input voltage = < -0.3 Volts, then 20…100 Ohms resistor must be added in series
(2): Maximum $V_{IH} = V_{DDmax} + 0.5$ Volt
n/a: not applicable

Parameter	Symbol	SCL Clk frequency <= 100KHz		SCL Clk frequency <= 350KHz		Unit
		Min.	**Max.**	**Min.**	**Max.**	
SCL clock frequency	f_{SCL}	0	100	0	350	KHz
Hold time (repeated) START condition. After this period, the first clock pulse is generated.	$t_{HD;STA}$	4.0	-	0.6	-	µs
LOW period of the SCL clock	t_{LOW}	4.7	-	1.3	-	µs
HIGH period of the SCL clock	t_{HIGH}	4.0	-	0.6	-	µs
Set-up time for a repeated START condition	$t_{SU;STA}$	4.7	-	0.6	-	µs
Data set-up time	$t_{SU;DAT}$	250	-	100	-	ns
Rise time of both SDA and SCL signals	t_r	-	1000	$20+0.1C_b$ (1)	300	ns
Fall time of both SDA and SCL signals	t_f	-	300	$20+0.1C_b$ (1)	300	ns
Set-up time for STOP condition	$t_{SU;STO}$	4.0	-	0.6	-	µs
Bus free time between a STOP and START condition	t_{BUF}	4.7	-	1.3	-	µs
Capacitive load for each bus line	C_b	0	400	-	400	pF
Noise margin at the LOW level for each connected device (including hysteresis)	V_{nL}	$0.1V_{DD}$	-	$0.1V_{DD}$	-	V
Noise margin at the HIGH level for each connected device (including hysteresis)	V_{nH}	$0.2V_{DD}$	-	$0.2V_{DD}$	-	V

Table 14: Two Wire Serial Interface - Characteristics of the SDA and SCL bus lines

Notes
(1): C_b = total capacitance of one bus line in pF.

Command Description

Communications between the TMC363 and a Two Wire Serial Bus Interface Master takes place via different commands.

Writing commands are used to:
- Program parameters of sine wave output (frequency, amplitude, softstart and offset)
- select between sine wave- and dc-output voltage
- Configure the amplitude of the step-up converter

Reading commands are used to:
- Get actual status of diagnostic flags
- Get actual status of amplitude amplification

write command									
Byte	Content	Structure							
		bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0	Slave Address	1	0	0	$OFFS_{Pin}$	$FS2_{Pin}$	$FS1_{Pin}$	$FS0_{Pin}$	0
1	config number	0	0	0	0	0	0	cnfg_1	cnfg_0
2	Config_0	Output	f_set_14	f_set_13	f_set_12	f_set_11	f_set_10	f_set_9	f_set_8
3	Config_1	f_set_7	f_set_6	f_set_5	f_set_4	f_set_3	f_set_2	f_set_1	f_set_0
4	Config_2	Offs_set	softstart	DAC1_5	DAC1_4	DAC1_3	DAC1_2	DAC1_1	DAC1_0
5	Config_3		STU_{max}	DAC2_5	DAC2_4	DAC2_3	DAC2_2	DAC2_1	DAC2_0

Table 15: write command

cnfg: The bits 'cnfg_0 … cnfg_1' appoints the config byte which is write first in the registers. Thus its possible to change one parameter by writing only one config byte instead of all config bytes. The start setup demands the configuration of all config bytes. In this case the write command consist of five bytes (config number = 0; config_0 … config_3 = see table 3). If its necessary to change only one parameter (e.g. amplitude of step-up converter) you have to write only two bytes (config number = 3; config_3 = see table 3).

Output: Output mode of the TMC363. Set this bit to '0' for sinus wave output. For dc voltage output set this bit to '1'.

f_set: $$f_{\sin} = \frac{f_{osc}}{2.097 * 10^6} * f_{set}$$
This value will not be considered in DC-mode.

Offs_set: Offset setting of the sine wave ('0' – no offst; '1' – 2V offset).

softstart: The soft start option is active when the bit 'softstart' is set to '1'. In this case the sine wave needs 250ms (at 8MHz f_{osc}) to reach the full amplitude. This time shrinks to 10ms by disabling the soft start mode.

DAC1: The amplitude of the sine wave is set by the bits 'DAC1_0 … DAC1_5'. If all bits are set to '1' the maximum amplitude (21V) is selected. Each bit correspond to 21V / 64. DAC1_5 is the MSB. The sine wave maximum peak value is calculate by the following formula:

$$V_{FB\_\max} = 4.2 \cdot V_{Ampl} \frac{n}{63}$$

n is the value of DAC1_0 … DAC1_5.

The maximum amplitude is limited by the supply voltage VSB ($U_{\sin\ limit} = U_{VSB} - 1V$).

STU_{max}: The STU_{max}-bit limits the maximum duty cycle of the step-up pwm.
'0': maximum duty cycle = 62% on (10/16)
'1': maximum duty cycle = 75% on (12/16)

DAC2: The amplitude of the step-up converter is set by the bits 'DAC2_0 … DAC2_5'. Each bit correspond to:

$$V_{LSB} = \frac{\left(\frac{R_{SU1}}{R_{SU2}} + 1\right) V_{Ref}}{64}$$

read command									
Byte	Content	Structure							
		bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0	Slave Address	1	0	0	$OFFS_{Pin}$	$FS2_{Pin}$	$FS1_{Pin}$	$FS0_{Pin}$	1

Table 16: read command

If this command is send from the master, the TMC363 will send two data bytes.

data byte from TMC363 in sine wave mode							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
				RES_FLG	OTPW	OT	SHORT
Ampl_7	Ampl_6	Ampl_5	Ampl_4	Ampl_3	Ampl_2	Ampl_1	Ampl_0

Table 5: read data byte in sine wave mode

RES_FLG: Status bit of reset flag

OTPW: Status bit of over temperature pre warning

OT: Status bit of over temperature

SHORT: Status bit of short circuit

Ampl: This byte corresponds to the control value of the sine wave amplitude. If this value is nearly the maximum (0xFF), the supply voltage (VSB) is too low for the selected amplitude.

DC Motor Driver Mode

The TMC363 can be set in DC motor driver mode with the FUNCSEL-pins. If both FUNCSEL-pins are connected to GND then DC motor driver mode is active.

write command in DC-mode									
Byte	Content	Structure							
		bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0	Slave Address	1	0	0	$OFFS_{Pin}$	$FS2_{Pin}$	$FS1_{Pin}$	$FS0_{Pin}$	0
1	config number	0	0	0	0	0	0	cnfg_1	cnfg_0
2	DC_Config_0	DIR	SD	CT_1	CT_0	PWM_11	PWM_10	PWM_9	PWM_8
3	DC_Config_1	PWM_7	PWM_6	PWM_5	PWM_4	PWM_3	PWM_2	PWM_1	PWM_0
4	DC_Config_2	0	0	0	0	Test_3	Test_2	Test_1	Test_0

Table 17: write command

cnfg: The bits 'cnfg_0 … cnfg_1' appoints the config byte which is write first in the registers. Thus its possible to change one parameter by writing only one config byte instead of all config bytes. The start setup demands the configuration of all config bytes. In this case the write command consist of four bytes (config number = 0; config_0 … config_2 = see table 5). If its necessary to change only one parameter (e.g. direction of rotation) you have to write only two bytes (config number = 0; config_0 = see table 3).

DIR: Direction of DC motor rotation ('0' – bridge 2 enable; '1' – bridge 1 enable)

SD: Slow decay mode ('0' – normal mode; '1' – slow decay active).

CT: Divider for DC-driver chopper frequency
'00': $f_{DC\text{-}chop} = f_{osc} / 256$
'01': $f_{DC\text{-}chop} = f_{osc} / 512$
'10': $f_{DC\text{-}chop} = f_{osc} / 1024$

PWM: '00…00': DC voltage is off
'11…11': DC voltage is maximum

TEST: Address for test multiplexer
'0000': Trigger Output
'0001': Bandgap reference
'0010': 2V reference
'0011': Temp. sense diodes
'0100': DAC out
'0101': Temperature pre warning
'0110': Overtemperature
'0111': CMP1
'1000': CMP2
'1001': CMP3
'1010': Short to Ground Detection
'1011': GP1
'1100': GP2
'1101': GN1
'1110': GN2
'1111': Vs under voltage comparator

read command in DC-mode									
Byte	Content	Structure							
		bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0	Slave Address	1	0	0	$OFFS_{Pin}$	$FS2_{Pin}$	$FS1_{Pin}$	$FS0_{Pin}$	1

Table 18: read command

If this command is send from the master, the TMC363 will send one data byte that includes several status bits.

data byte from TMC363 in DC motor driver mode							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
FUNC_SEL				RES_FLG	OTPW	OT	SHORT

Table 19: read data byte in DC motor driver mode

FUNC_SEL: Status bit of function selection

RES_FLG: Status bit of reset flag

OTPW: Status bit of over temperature pre warning

OT: Status bit of over temperature

SHORT: Status bit of short circuit

ESD protection

Please be aware, that the TMC363 is an ESD sensitive device due to integrated high performance MOS transistors.

ESD sensitive device

If the ICs are manually handled before / during soldering, special precautions have to be taken to avoid ESD voltages above 100V HBM (Human body model). For automated SMD equipment the internal device protection is specified with 1000V CDM (charged device model), tbf.

When soldered to the application board, all inputs and outputs withstand at least 1000V HBM.