DS18B20
Programmable Resolution 1-Wire Digital Thermometer

DESCRIPTION

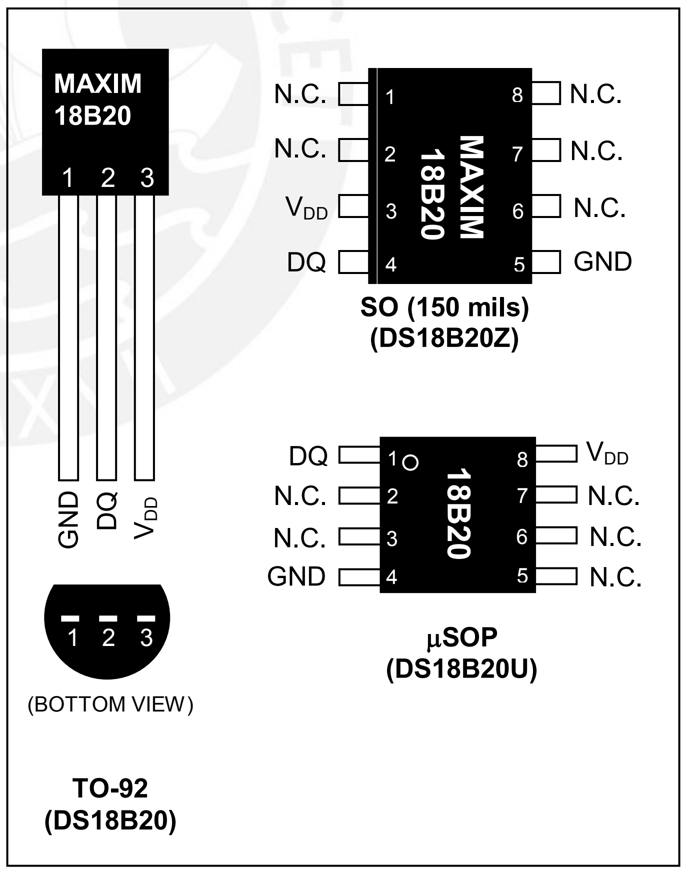
The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. It has an operating temperature range of -55°C to +125°C and is accurate to ±0.5°C over the range of -10°C to +85°C. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply.

Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

FEATURES

- Unique 1-Wire® Interface Requires Only One Port Pin for Communication
- Each Device has a Unique 64-Bit Serial Code Stored in an On-Board ROM
- Multidrop Capability Simplifies Distributed Temperature-Sensing Applications
- Requires No External Components
- Can Be Powered from Data Line; Power Supply Range is 3.0V to 5.5V
- Measures Temperatures from -55°C to +125°C (-67°F to +257°F)
- ±0.5°C Accuracy from -10°C to +85°C
- Thermometer Resolution is User Selectable from 9 to 12 Bits
- Converts Temperature to 12-Bit Digital Word in 750ms (Max)
- User-Definable Nonvolatile (NV) Alarm Settings
- Alarm Search Command Identifies and Addresses Devices Whose Temperature is Outside Programmed Limits (Temperature Alarm Condition)
- Available in 8-Pin SO (150 mils), 8-Pin µSOP, and 3-Pin TO-92 Packages
- Software Compatible with the DS1822
- Applications Include Thermostatic Controls, Industrial Systems, Consumer Products, Thermometers, or Any Thermally Sensitive System

PIN CONFIGURATIONS



1-Wire is a registered trademark of Maxim Integrated Products, Inc.

ORDERING INFORMATION

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
DS18B20	-55°C to +125°C	3 TO-92	18B20
DS18B20+	-55°C to +125°C	3 TO-92	18B20
DS18B20/T&R	-55°C to +125°C	3 TO-92 (2000 Piece)	18B20
DS18B20+T&R	-55°C to +125°C	3 TO-92 (2000 Piece)	18B20
DS18B20-SL/T&R	-55°C to +125°C	3 TO-92 (2000 Piece)*	18B20
DS18B20-SL+T&R	-55°C to +125°C	3 TO-92 (2000 Piece)*	18B20
DS18B20U	-55°C to +125°C	8 µSOP	18B20
DS18B20U+	-55°C to +125°C	8 µSOP	18B20
DS18B20U/T&R	-55°C to +125°C	8 µSOP (3000 Piece)	18B20
DS18B20U+T&R	-55°C to +125°C	8 µSOP (3000 Piece)	18B20
DS18B20Z	-55°C to +125°C	8 SO	DS18B20
DS18B20Z+	-55°C to +125°C	8 SO	DS18B20
DS18B20Z/T&R	-55°C to +125°C	8 SO (2500 Piece)	DS18B20
DS18B20Z+T&R	-55°C to +125°C	8 SO (2500 Piece)	DS18B20

+Denotes a lead-free package. A "+" will appear on the top mark of lead-free packages.
T&R = Tape and reel.
**TO-92 packages in tape and reel can be ordered with straight or formed leads. Choose "SL" for straight leads. Bulk TO-92 orders are straight leads only.*

PIN DESCRIPTION

PIN			NAME	FUNCTION
SO	µSOP	TO-92		
1, 2, 6, 7, 8	2, 3, 5, 6, 7	—	N.C.	No Connection
3	8	3	V_{DD}	Optional V_{DD}. V_{DD} must be grounded for operation in parasite power mode.
4	1	2	DQ	Data Input/Output. Open-drain 1-Wire interface pin. Also provides power to the device when used in parasite power mode (see the *Powering the DS18B20* section.)
5	4	1	GND	Ground

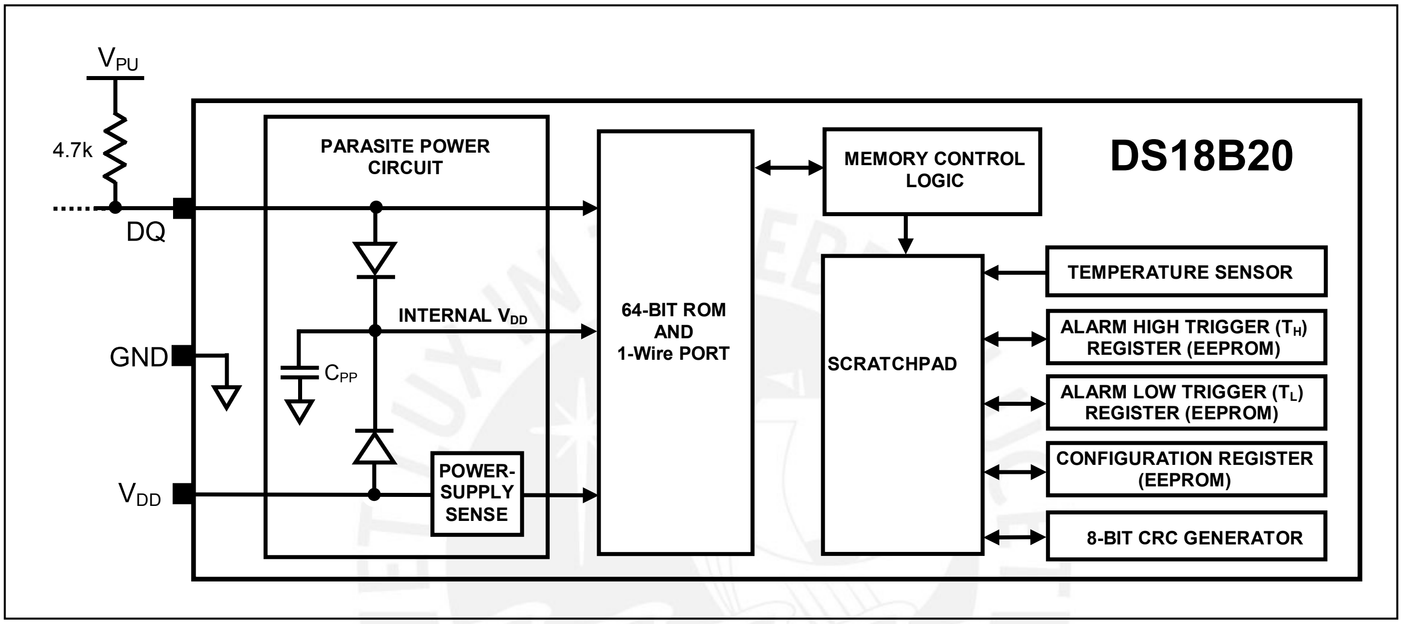
OVERVIEW

Figure 1 shows a block diagram of the DS18B20, and pin descriptions are given in the *Pin Description* table. The 64-bit ROM stores the device's unique serial code. The scratchpad memory contains the 2-byte temperature register that stores the digital output from the temperature sensor. In addition, the scratchpad provides access to the 1-byte upper and lower alarm trigger registers (T_H and T_L) and the 1-byte configuration register. The configuration register allows the user to set the resolution of the temperature-to-digital conversion to 9, 10, 11, or 12 bits. The T_H, T_L, and configuration registers are nonvolatile (EEPROM), so they will retain data when the device is powered down.

The DS18B20 uses Maxim's exclusive 1-Wire bus protocol that implements bus communication using one control signal. The control line requires a weak pullup resistor since all devices are linked to the bus via a 3-state or open-drain port (the DQ pin in the case of the DS18B20). In this bus system, the microprocessor (the master device) identifies and addresses devices on the bus using each device's unique 64-bit code. Because each device has a unique code, the number of devices that can be addressed on one bus is virtually unlimited. The 1-Wire bus protocol, including detailed explanations of the commands and "time slots," is covered in the *1-Wire Bus System* section.

Another feature of the DS18B20 is the ability to operate without an external power supply. Power is instead supplied through the 1-Wire pullup resistor via the DQ pin when the bus is high. The high bus signal also charges an internal capacitor (C_{PP}), which then supplies power to the device when the bus is low. This method of deriving power from the 1-Wire bus is referred to as "parasite power." As an alternative, the DS18B20 may also be powered by an external supply on V_{DD}.

Figure 1. DS18B20 Block Diagram



OPERATION—MEASURING TEMPERATURE

The core functionality of the DS18B20 is its direct-to-digital temperature sensor. The resolution of the temperature sensor is user-configurable to 9, 10, 11, or 12 bits, corresponding to increments of 0.5°C, 0.25°C, 0.125°C, and 0.0625°C, respectively. The default resolution at power-up is 12-bit. The DS18B20 powers up in a low-power idle state. To initiate a temperature measurement and A-to-D conversion, the master must issue a Convert T [44h] command. Following the conversion, the resulting thermal data is stored in the 2-byte temperature register in the scratchpad memory and the DS18B20 returns to its idle state. If the DS18B20 is powered by an external supply, the master can issue "read time slots" (see the *1-Wire Bus System* section) after the Convert T command and the DS18B20 will respond by transmitting 0 while the temperature conversion is in progress and 1 when the conversion is done. If the DS18B20 is powered with parasite power, this notification technique cannot be used since the bus must be pulled high by a strong pullup during the entire temperature conversion. The bus requirements for parasite power are explained in detail in the *Powering the DS18B20* section.

The DS18B20 output temperature data is calibrated in degrees Celsius; for Fahrenheit applications, a lookup table or conversion routine must be used. The temperature data is stored as a 16-bit sign-extended two's complement number in the temperature register (see Figure 2). The sign bits (S) indicate if the temperature is positive or negative: for positive numbers S = 0 and for negative numbers S = 1. If the DS18B20 is configured for 12-bit resolution, all bits in the temperature register will contain valid data. For 11-bit resolution, bit 0 is undefined. For 10-bit resolution, bits 1 and 0 are undefined, and for 9-bit resolution bits 2, 1, and 0 are undefined. Table 1 gives examples of digital output data and the corresponding temperature reading for 12-bit resolution conversions.

Figure 2. Temperature Register Format

	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
LS BYTE	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}

	BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8
MS BYTE	S	S	S	S	S	2^6	2^5	2^4

S = SIGN

Table 1. Temperature/Data Relationship

TEMPERATURE (°C)	DIGITAL OUTPUT (BINARY)	DIGITAL OUTPUT (HEX)
+125	0000 0111 1101 0000	07D0h
+85*	0000 0101 0101 0000	0550h
+25.0625	0000 0001 1001 0001	0191h
+10.125	0000 0000 1010 0010	00A2h
+0.5	0000 0000 0000 1000	0008h
0	0000 0000 0000 0000	0000h
-0.5	1111 1111 1111 1000	FFF8h
-10.125	1111 1111 0101 1110	FF5Eh
-25.0625	1111 1110 0110 1111	FE6Fh
-55	1111 1100 1001 0000	FC90h

**The power-on reset value of the temperature register is +85°C.*

OPERATION—ALARM SIGNALING

After the DS18B20 performs a temperature conversion, the temperature value is compared to the user-defined two's complement alarm trigger values stored in the 1-byte T_H and T_L registers (see Figure 3). The sign bit (S) indicates if the value is positive or negative: for positive numbers S = 0 and for negative numbers S = 1. The T_H and T_L registers are nonvolatile (EEPROM) so they will retain data when the device is powered down. T_H and T_L can be accessed through bytes 2 and 3 of the scratchpad as explained in the *Memory* section.

Figure 3. T_H and T_L Register Format

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
S	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Only bits 11 through 4 of the temperature register are used in the T_H and T_L comparison since T_H and T_L are 8-bit registers. If the measured temperature is lower than or equal to T_L or higher than or equal to T_H, an alarm condition exists and an alarm flag is set inside the DS18B20. This flag is updated after every temperature measurement; therefore, if the alarm condition goes away, the flag will be turned off after the next temperature conversion.

The master device can check the alarm flag status of all DS18B20s on the bus by issuing an Alarm Search [ECh] command. Any DS18B20s with a set alarm flag will respond to the command, so the master can determine exactly which DS18B20s have experienced an alarm condition. If an alarm condition exists and the T_H or T_L settings have changed, another temperature conversion should be done to validate the alarm condition.

POWERING THE DS18B20

The DS18B20 can be powered by an external supply on the V_{DD} pin, or it can operate in "parasite power" mode, which allows the DS18B20 to function without a local external supply. Parasite power is very useful for applications that require remote temperature sensing or that are very space constrained. Figure 1 shows the DS18B20's parasite-power control circuitry, which "steals" power from the 1-Wire bus via the DQ pin when the bus is high. The stolen charge powers the DS18B20 while the bus is high, and some of the charge is stored on the parasite power capacitor (C_{PP}) to provide power when the bus is low. When the DS18B20 is used in parasite power mode, the V_{DD} pin must be connected to ground.

In parasite power mode, the 1-Wire bus and C_{PP} can provide sufficient current to the DS18B20 for most operations as long as the specified timing and voltage requirements are met (see the *DC Electrical Characteristics* and *AC Electrical Characteristics*). However, when the DS18B20 is performing temperature conversions or copying data from the scratchpad memory to EEPROM, the operating current can be as high as 1.5mA. This current can cause an unacceptable voltage drop across the weak 1-Wire pullup resistor and is more current than can be supplied by C_{PP}. To assure that the DS18B20 has sufficient supply current, it is necessary to provide a strong pullup on the 1-Wire bus whenever temperature conversions are taking place or data is being copied from the scratchpad to EEPROM. This can be accomplished by using a MOSFET to pull the bus directly to the rail as shown in Figure 4. The 1-Wire bus must be switched to the strong pullup within 10µs (max) after a Convert T [44h] or Copy Scratchpad [48h] command is issued, and the bus must be held high by the pullup for the duration of the conversion (t_{CONV}) or data transfer (t_{WR} = 10ms). No other activity can take place on the 1-Wire bus while the pullup is enabled.

The DS18B20 can also be powered by the conventional method of connecting an external power supply to the V_{DD} pin, as shown in Figure 5. The advantage of this method is that the MOSFET pullup is not required, and the 1-Wire bus is free to carry other traffic during the temperature conversion time.

The use of parasite power is not recommended for temperatures above +100°C since the DS18B20 may not be able to sustain communications due to the higher leakage currents that can exist at these temperatures. For applications in which such temperatures are likely, it is strongly recommended that the DS18B20 be powered by an external power supply.

In some situations the bus master may not know whether the DS18B20s on the bus are parasite powered or powered by external supplies. The master needs this information to determine if the strong bus pullup should be used during temperature conversions. To get this information, the master can issue a Skip ROM [CCh] command followed by a Read Power Supply [B4h] command followed by a "read time slot". During the read time slot, parasite powered DS18B20s will pull the bus low, and externally powered DS18B20s will let the bus remain high. If the bus is pulled low, the master knows that it must supply the strong pullup on the 1-Wire bus during temperature conversions.

Figure 4. Supplying the Parasite-Powered DS18B20 During Temperature Conversions

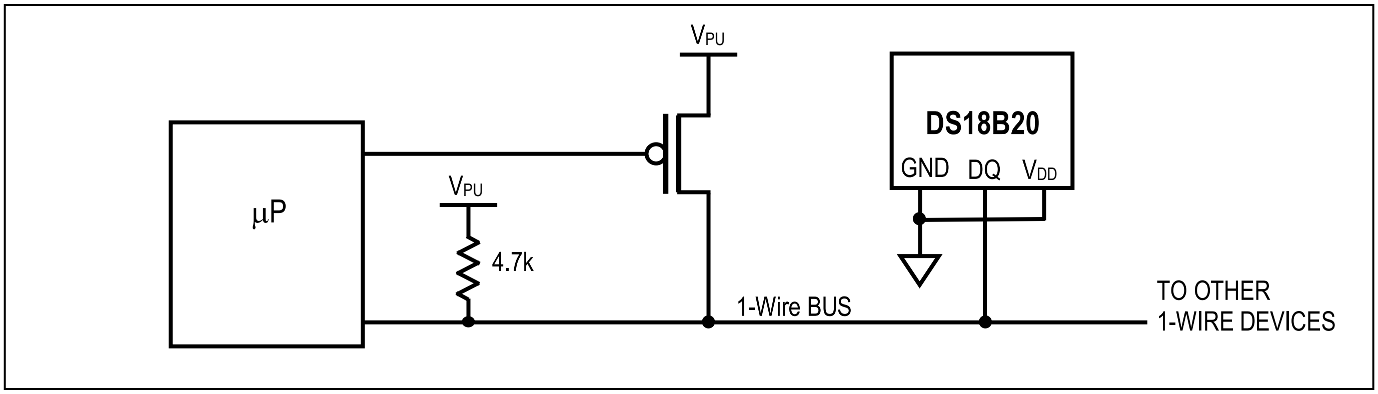
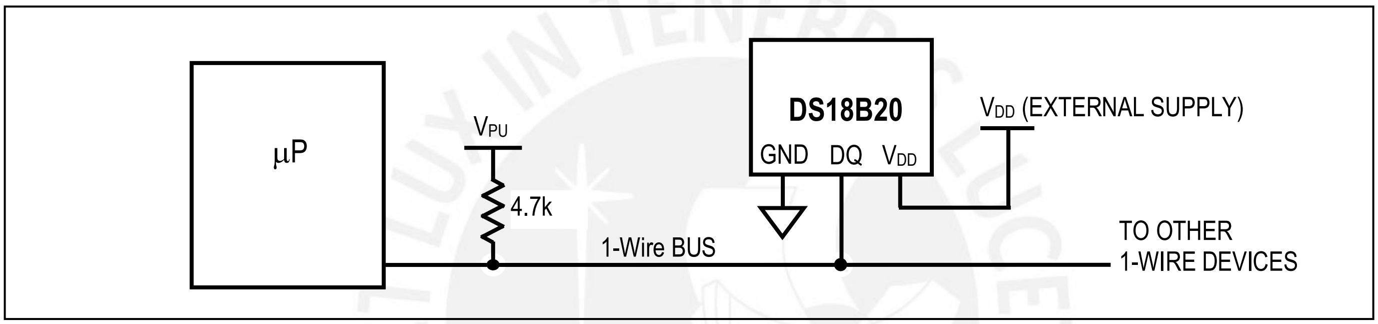


Figure 5. Powering the DS18B20 with an External Supply



64-BIT LASERED ROM CODE

Each DS18B20 contains a unique 64–bit code (see Figure 6) stored in ROM. The least significant 8 bits of the ROM code contain the DS18B20's 1-Wire family code: 28h. The next 48 bits contain a unique serial number. The most significant 8 bits contain a cyclic redundancy check (CRC) byte that is calculated from the first 56 bits of the ROM code. A detailed explanation of the CRC bits is provided in the *CRC Generation* section. The 64-bit ROM code and associated ROM function control logic allow the DS18B20 to operate as a 1-Wire device using the protocol detailed in the *1-Wire Bus System* section.

Figure 6. 64-Bit Lasered ROM Code

8-BIT CRC		48-BIT SERIAL NUMBER		8-BIT FAMILY CODE (28h)	
MSB	LSB	MSB	LSB	MSB	LSB

MEMORY

The DS18B20's memory is organized as shown in Figure 7. The memory consists of an SRAM scratchpad with nonvolatile EEPROM storage for the high and low alarm trigger registers (T_H and T_L) and configuration register. Note that if the DS18B20 alarm function is not used, the T_H and T_L registers can serve as general-purpose memory. All memory commands are described in detail in the *DS18B20 Function Commands* section.

Byte 0 and byte 1 of the scratchpad contain the LSB and the MSB of the temperature register, respectively. These bytes are read-only. Bytes 2 and 3 provide access to T_H and T_L registers. Byte 4 contains the configuration register data, which is explained in detail in the *Configuration Register* section. Bytes 5, 6, and 7 are reserved for internal use by the device and cannot be overwritten.

Byte 8 of the scratchpad is read-only and contains the CRC code for bytes 0 through 7 of the scratchpad. The DS18B20 generates this CRC using the method described in the *CRC Generation* section.

Data is written to bytes 2, 3, and 4 of the scratchpad using the Write Scratchpad [4Eh] command; the data must be transmitted to the DS18B20 starting with the least significant bit of byte 2. To verify data integrity, the scratchpad can be read (using the Read Scratchpad [BEh] command) after the data is written. When reading the scratchpad, data is transferred over the 1-Wire bus starting with the least significant bit of byte 0. To transfer the T_H, T_L and configuration data from the scratchpad to EEPROM, the master must issue the Copy Scratchpad [48h] command.

Data in the EEPROM registers is retained when the device is powered down; at power-up the EEPROM data is reloaded into the corresponding scratchpad locations. Data can also be reloaded from EEPROM to the scratchpad at any time using the Recall E^2 [B8h] command. The master can issue read time slots following the Recall E^2 command and the DS18B20 will indicate the status of the recall by transmitting 0 while the recall is in progress and 1 when the recall is done.

Figure 7. DS18B20 Memory Map

	SCRATCHPAD (POWER-UP STATE)			EEPROM
Byte 0	Temperature LSB (50h)	(85°C)		
Byte 1	Temperature MSB (05h)			
Byte 2	T_H Register or User Byte 1*		⟷	T_H Register or User Byte 1
Byte 3	T_L Register or User Byte 2*		⟷	T_L Register or User Byte 2
Byte 4	Configuration Register*		⟷	Configuration Register
Byte 5	Reserved (FFh)			
Byte 6	Reserved			
Byte 7	Reserved (10h)			
Byte 8	CRC*			

**Power-up state depends on value(s) stored in EEPROM.*

CONFIGURATION REGISTER

Byte 4 of the scratchpad memory contains the configuration register, which is organized as illustrated in Figure 8**.** The user can set the conversion resolution of the DS18B20 using the R0 and R1 bits in this register as shown in Table 2. The power-up default of these bits is R0 = 1 and R1 = 1 (12-bit resolution). Note that there is a direct tradeoff between resolution and conversion time. Bit 7 and bits 0 to 4 in the configuration register are reserved for internal use by the device and cannot be overwritten.

Figure 8. Configuration Register

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	R1	R0	1	1	1	1	1

Table 2. Thermometer Resolution Configuration

R1	R0	RESOLUTION (BITS)	MAX CONVERSION TIME	
0	0	9	93.75ms	(t_{CONV}/8)
0	1	10	187.5ms	(t_{CONV}/4)
1	0	11	375ms	(t_{CONV}/2)
1	1	12	750ms	(t_{CONV})

CRC GENERATION

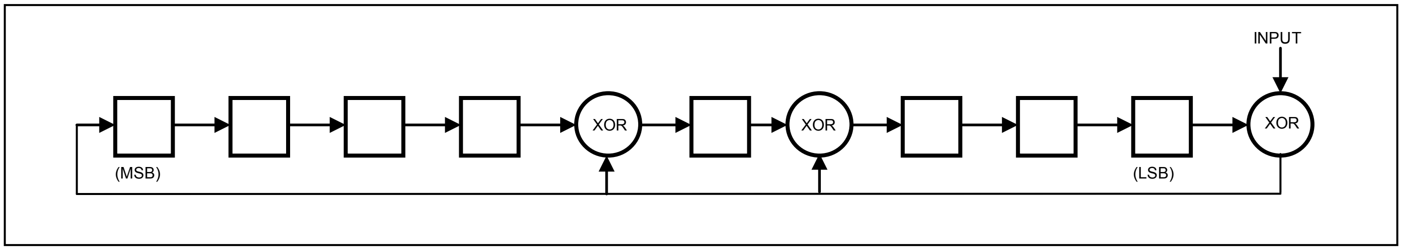
CRC bytes are provided as part of the DS18B20's 64-bit ROM code and in the 9th byte of the scratchpad memory. The ROM code CRC is calculated from the first 56 bits of the ROM code and is contained in the most significant byte of the ROM. The scratchpad CRC is calculated from the data stored in the scratchpad, and therefore it changes when the data in the scratchpad changes. The CRCs provide the bus master with a method of data validation when data is read from the DS18B20. To verify that data has been read correctly, the bus master must re-calculate the CRC from the received data and then compare this value to either the ROM code CRC (for ROM reads) or to the scratchpad CRC (for scratchpad reads). If the calculated CRC matches the read CRC, the data has been received error free. The comparison of CRC values and the decision to continue with an operation are determined entirely by the bus master. There is no circuitry inside the DS18B20 that prevents a command sequence from proceeding if the DS18B20 CRC (ROM or scratchpad) does not match the value generated by the bus master.

The equivalent polynomial function of the CRC (ROM or scratchpad) is:

$$CRC = X^8 + X^5 + X^4 + 1$$

The bus master can re-calculate the CRC and compare it to the CRC values from the DS18B20 using the polynomial generator shown in Figure 9. This circuit consists of a shift register and XOR gates, and the shift register bits are initialized to 0. Starting with the least significant bit of the ROM code or the least significant bit of byte 0 in the scratchpad, one bit at a time should shifted into the shift register. After shifting in the 56th bit from the ROM or the most significant bit of byte 7 from the scratchpad, the polynomial generator will contain the re-calculated CRC. Next, the 8-bit ROM code or scratchpad CRC from the DS18B20 must be shifted into the circuit. At this point, if the re-calculated CRC was correct, the shift register will contain all 0s. Additional information about the Maxim 1-Wire cyclic redundancy check is available in *Application Note 27: Understanding and Using Cyclic Redundancy Checks with Maxim iButton Products*.

Figure 9. CRC Generator



1-WIRE BUS SYSTEM

The 1-Wire bus system uses a single bus master to control one or more slave devices. The DS18B20 is always a slave. When there is only one slave on the bus, the system is referred to as a "single-drop" system; the system is "multidrop" if there are multiple slaves on the bus.

All data and commands are transmitted least significant bit first over the 1-Wire bus.

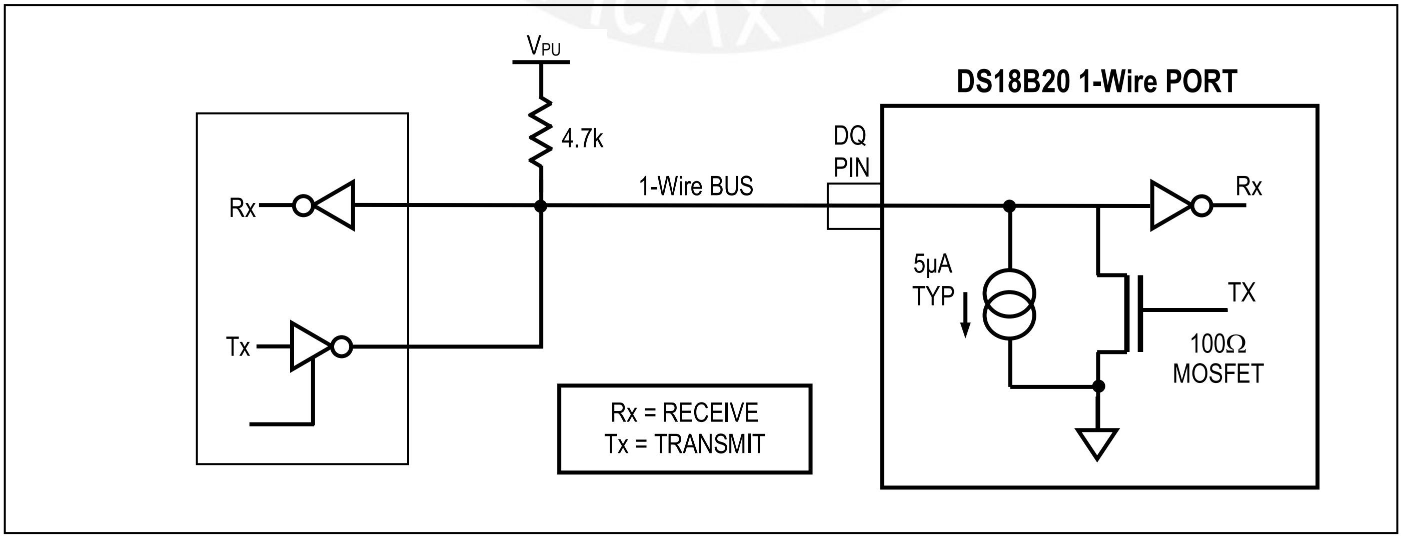
The following discussion of the 1-Wire bus system is broken down into three topics: hardware configuration, transaction sequence, and 1-Wire signaling (signal types and timing).

HARDWARE CONFIGURATION

The 1-Wire bus has by definition only a single data line. Each device (master or slave) interfaces to the data line via an open-drain or 3-state port. This allows each device to "release" the data line when the device is not transmitting data so the bus is available for use by another device. The 1-Wire port of the DS18B20 (the DQ pin) is open drain with an internal circuit equivalent to that shown in Figure 10.

The 1-Wire bus requires an external pullup resistor of approximately 5kΩ; thus, the idle state for the 1-Wire bus is high. If for any reason a transaction needs to be suspended, the bus MUST be left in the idle state if the transaction is to resume. Infinite recovery time can occur between bits so long as the 1-Wire bus is in the inactive (high) state during the recovery period. If the bus is held low for more than 480µs, all components on the bus will be reset.

Figure 10. Hardware Configuration



TRANSACTION SEQUENCE

The transaction sequence for accessing the DS18B20 is as follows:

Step 1. Initialization

Step 2. ROM Command (followed by any required data exchange)

Step 3. DS18B20 Function Command (followed by any required data exchange)

It is very important to follow this sequence every time the DS18B20 is accessed, as the DS18B20 will not respond if any steps in the sequence are missing or out of order. Exceptions to this rule are the Search ROM [F0h] and Alarm Search [ECh] commands. After issuing either of these ROM commands, the master must return to Step 1 in the sequence.

INITIALIZATION

All transactions on the 1-Wire bus begin with an initialization sequence. The initialization sequence consists of a reset pulse transmitted by the bus master followed by presence pulse(s) transmitted by the slave(s). The presence pulse lets the bus master know that slave devices (such as the DS18B20) are on the bus and are ready to operate. Timing for the reset and presence pulses is detailed in the *1-Wire Signaling* section.

ROM COMMANDS

After the bus master has detected a presence pulse, it can issue a ROM command. These commands operate on the unique 64-bit ROM codes of each slave device and allow the master to single out a specific device if many are present on the 1-Wire bus. These commands also allow the master to determine how many and what types of devices are present on the bus or if any device has experienced an alarm condition. There are five ROM commands, and each command is 8 bits long. The master device must issue an appropriate ROM command before issuing a DS18B20 function command. A flowchart for operation of the ROM commands is shown in Figure 11.

SEARCH ROM [F0h]

When a system is initially powered up, the master must identify the ROM codes of all slave devices on the bus, which allows the master to determine the number of slaves and their device types. The master learns the ROM codes through a process of elimination that requires the master to perform a Search ROM cycle (i.e., Search ROM command followed by data exchange) as many times as necessary to identify all of the slave devices. If there is only one slave on the bus, the simpler Read ROM command (see below) can be used in place of the Search ROM process. For a detailed explanation of the Search ROM procedure, refer to the *iButton® Book of Standards* at www.maxim-ic.com/ibuttonbook. After every Search ROM cycle, the bus master must return to Step 1 (Initialization) in the transaction sequence.

READ ROM [33h]

This command can only be used when there is one slave on the bus. It allows the bus master to read the slave's 64-bit ROM code without using the Search ROM procedure. If this command is used when there is more than one slave present on the bus, a data collision will occur when all the slaves attempt to respond at the same time.

MATCH ROM [55h]

The match ROM command followed by a 64-bit ROM code sequence allows the bus master to address a specific slave device on a multidrop or single-drop bus. Only the slave that exactly matches the 64-bit ROM code sequence will respond to the function command issued by the master; all other slaves on the bus will wait for a reset pulse.

iButton is a registered trademark of Maxim Integrated Products, Inc.

SKIP ROM [CCh]
The master can use this command to address all devices on the bus simultaneously without sending out any ROM code information. For example, the master can make all DS18B20s on the bus perform simultaneous temperature conversions by issuing a Skip ROM command followed by a Convert T [44h] command.

Note that the Read Scratchpad [BEh] command can follow the Skip ROM command only if there is a single slave device on the bus. In this case, time is saved by allowing the master to read from the slave without sending the device's 64-bit ROM code. A Skip ROM command followed by a Read Scratchpad command will cause a data collision on the bus if there is more than one slave since multiple devices will attempt to transmit data simultaneously.

ALARM SEARCH [ECh]
The operation of this command is identical to the operation of the Search ROM command except that only slaves with a set alarm flag will respond. This command allows the master device to determine if any DS18B20s experienced an alarm condition during the most recent temperature conversion. After every Alarm Search cycle (i.e., Alarm Search command followed by data exchange), the bus master must return to Step 1 (Initialization) in the transaction sequence. See the *Operation—Alarm Signaling* section for an explanation of alarm flag operation.

DS18B20 FUNCTION COMMANDS
After the bus master has used a ROM command to address the DS18B20 with which it wishes to communicate, the master can issue one of the DS18B20 function commands. These commands allow the master to write to and read from the DS18B20's scratchpad memory, initiate temperature conversions and determine the power supply mode. The DS18B20 function commands, which are described below, are summarized in Table 3 and illustrated by the flowchart in Figure 12.

CONVERT T [44h]
This command initiates a single temperature conversion. Following the conversion, the resulting thermal data is stored in the 2-byte temperature register in the scratchpad memory and the DS18B20 returns to its low-power idle state. If the device is being used in parasite power mode, within 10µs (max) after this command is issued the master must enable a strong pullup on the 1-Wire bus for the duration of the conversion (t_{CONV}) as described in the *Powering the DS18B20* section. If the DS18B20 is powered by an external supply, the master can issue read time slots after the Convert T command and the DS18B20 will respond by transmitting a 0 while the temperature conversion is in progress and a 1 when the conversion is done. In parasite power mode this notification technique cannot be used since the bus is pulled high by the strong pullup during the conversion.

WRITE SCRATCHPAD [4Eh]
This command allows the master to write 3 bytes of data to the DS18B20's scratchpad. The first data byte is written into the T_H register (byte 2 of the scratchpad), the second byte is written into the T_L register (byte 3), and the third byte is written into the configuration register (byte 4). Data must be transmitted least significant bit first. All three bytes MUST be written before the master issues a reset, or the data may be corrupted.

READ SCRATCHPAD [BEh]
This command allows the master to read the contents of the scratchpad. The data transfer starts with the least significant bit of byte 0 and continues through the scratchpad until the 9th byte (byte 8 – CRC) is read. The master may issue a reset to terminate reading at any time if only part of the scratchpad data is needed.

COPY SCRATCHPAD [48h]

This command copies the contents of the scratchpad T_H, T_L and configuration registers (bytes 2, 3 and 4) to EEPROM. If the device is being used in parasite power mode, within 10µs (max) after this command is issued the master must enable a strong pullup on the 1-Wire bus for at least 10ms as described in the *Powering the DS18B20* section.

RECALL E² [B8h]

This command recalls the alarm trigger values (T_H and T_L) and configuration data from EEPROM and places the data in bytes 2, 3, and 4, respectively, in the scratchpad memory. The master device can issue read time slots following the Recall E^2 command and the DS18B20 will indicate the status of the recall by transmitting 0 while the recall is in progress and 1 when the recall is done. The recall operation happens automatically at power-up, so valid data is available in the scratchpad as soon as power is applied to the device.

READ POWER SUPPLY [B4h]

The master device issues this command followed by a read time slot to determine if any DS18B20s on the bus are using parasite power. During the read time slot, parasite powered DS18B20s will pull the bus low, and externally powered DS18B20s will let the bus remain high. See the *Powering the DS18B20* section for usage information for this command.

Table 3. DS18B20 Function Command Set

COMMAND	DESCRIPTION	PROTOCOL	1-Wire BUS ACTIVITYAFTER COMMAND IS ISSUED	NOTES
TEMPERATURE CONVERSION COMMANDS				
Convert T	Initiates temperature conversion.	44h	DS18B20 transmits conversion status to master (not applicable for parasite-powered DS18B20s).	1
MEMORY COMMANDS				
Read Scratchpad	Reads the entire scratchpad including the CRC byte.	BEh	DS18B20 transmits up to 9 data bytes to master.	2
Write Scratchpad	Writes data into scratchpad bytes 2, 3, and 4 (T_H, T_L, and configuration registers).	4Eh	Master transmits 3 data bytes to DS18B20.	3
Copy Scratchpad	Copies T_H, T_L, and configuration register data from the scratchpad to EEPROM.	48h	None	1
Recall E^2	Recalls T_H, T_L, and configuration register data from EEPROM to the scratchpad.	B8h	DS18B20 transmits recall status to master.	
Read Power Supply	Signals DS18B20 power supply mode to the master.	B4h	DS18B20 transmits supply status to master.	

Note 1: For parasite-powered DS18B20s, the master must enable a strong pullup on the 1-Wire bus during temperature conversions and copies from the scratchpad to EEPROM. No other bus activity may take place during this time.
Note 2: The master can interrupt the transmission of data at any time by issuing a reset.
Note 3: All three bytes must be written before a reset is issued.

Figure 11. ROM Commands Flowchart

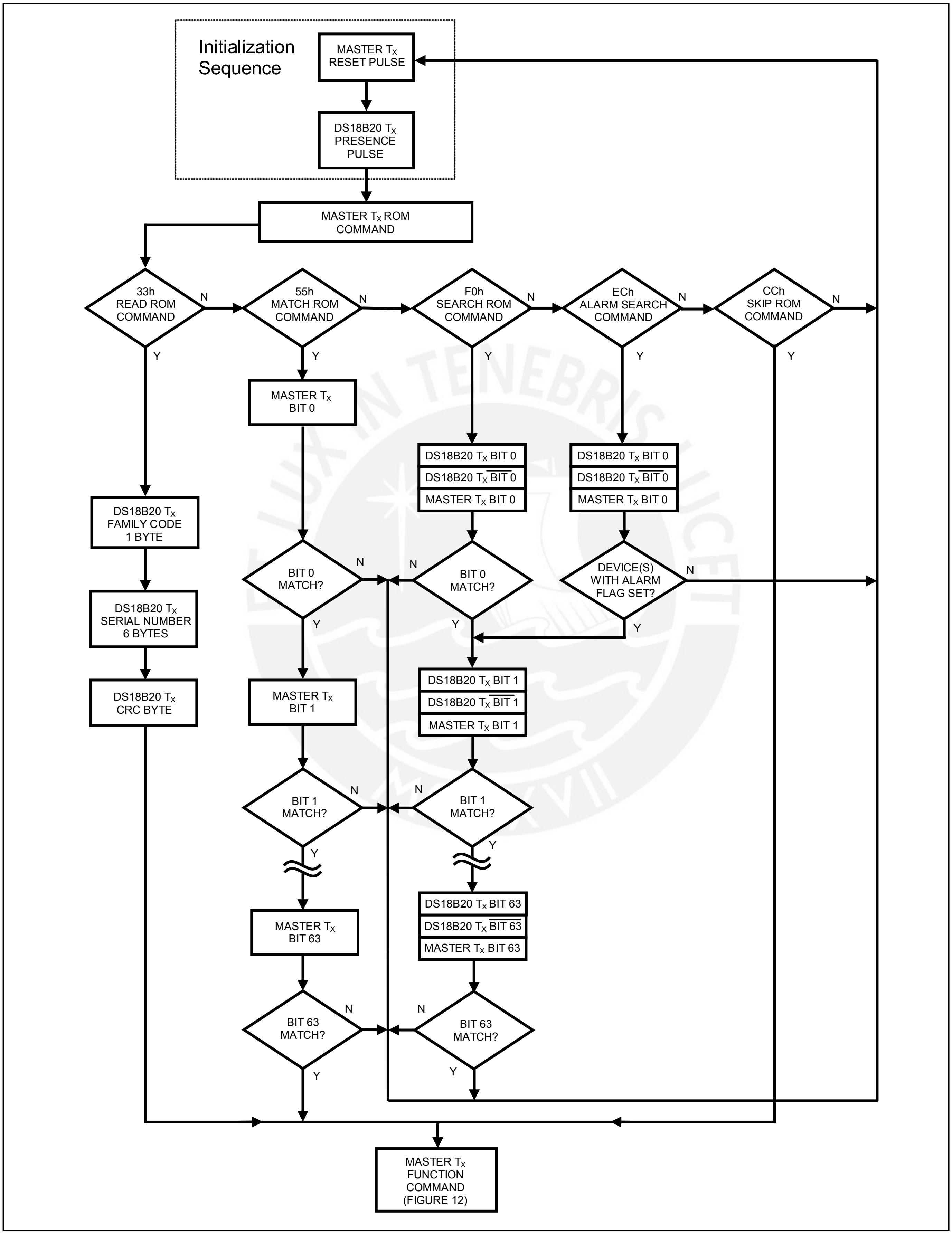
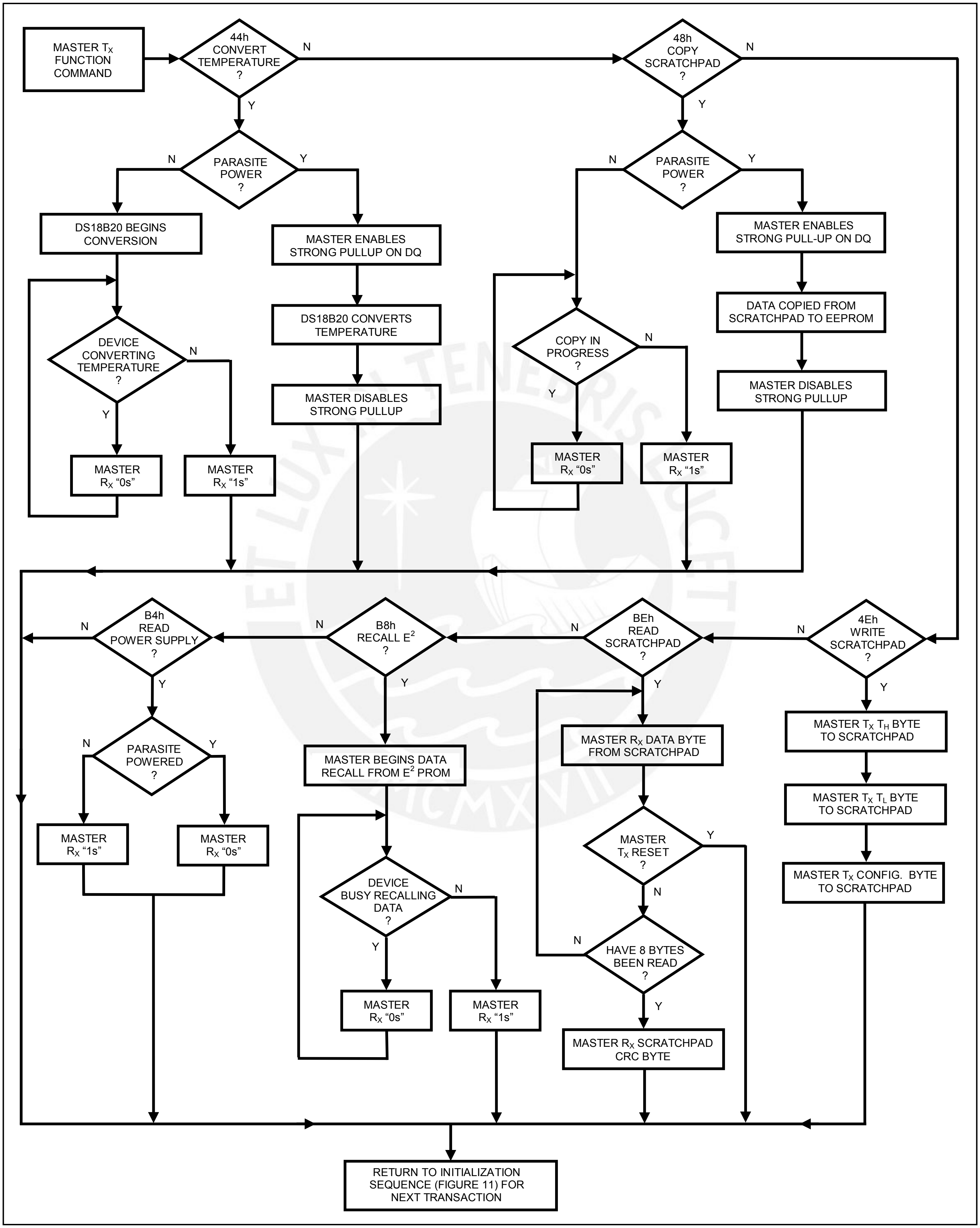


Figure 12. DS18B20 Function Commands Flowchart



1-WIRE SIGNALING

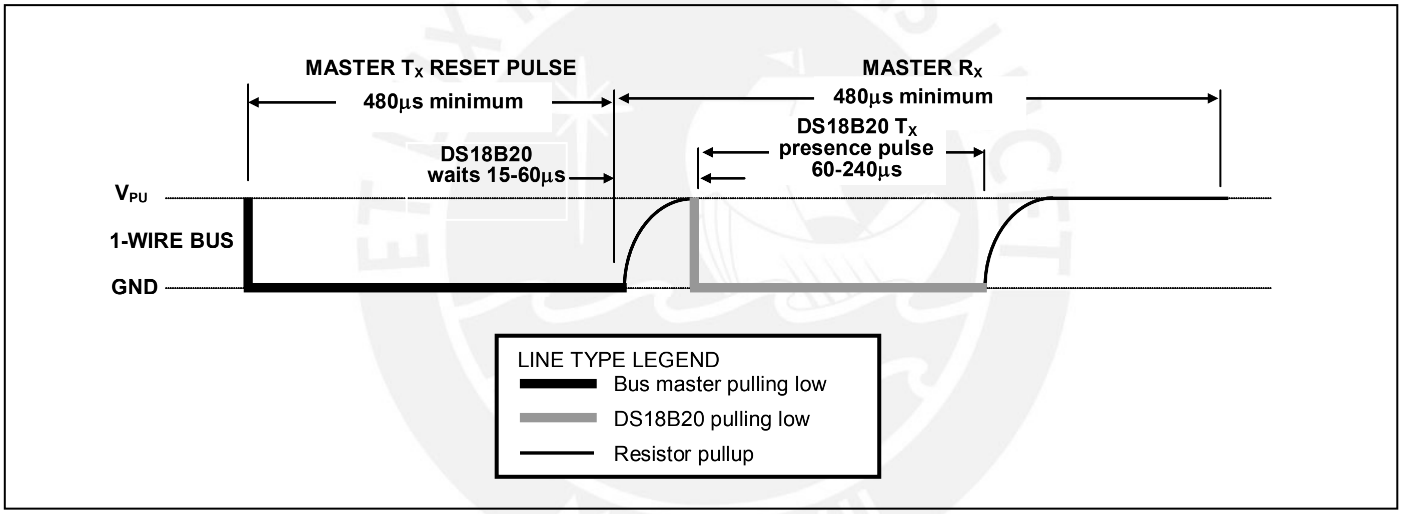
The DS18B20 uses a strict 1-Wire communication protocol to ensure data integrity. Several signal types are defined by this protocol: reset pulse, presence pulse, write 0, write 1, read 0, and read 1. The bus master initiates all these signals, with the exception of the presence pulse.

INITIALIZATION PROCEDURE—RESET AND PRESENCE PULSES

All communication with the DS18B20 begins with an initialization sequence that consists of a reset pulse from the master followed by a presence pulse from the DS18B20. This is illustrated in Figure 13. When the DS18B20 sends the presence pulse in response to the reset, it is indicating to the master that it is on the bus and ready to operate.

During the initialization sequence the bus master transmits (T_X) the reset pulse by pulling the 1-Wire bus low for a minimum of 480µs. The bus master then releases the bus and goes into receive mode (R_X). When the bus is released, the 5kΩ pullup resistor pulls the 1-Wire bus high. When the DS18B20 detects this rising edge, it waits 15µs to 60µs and then transmits a presence pulse by pulling the 1-Wire bus low for 60µs to 240µs.

Figure 13. Initialization Timing



READ/WRITE TIME SLOTS

The bus master writes data to the DS18B20 during write time slots and reads data from the DS18B20 during read time slots. One bit of data is transmitted over the 1-Wire bus per time slot.

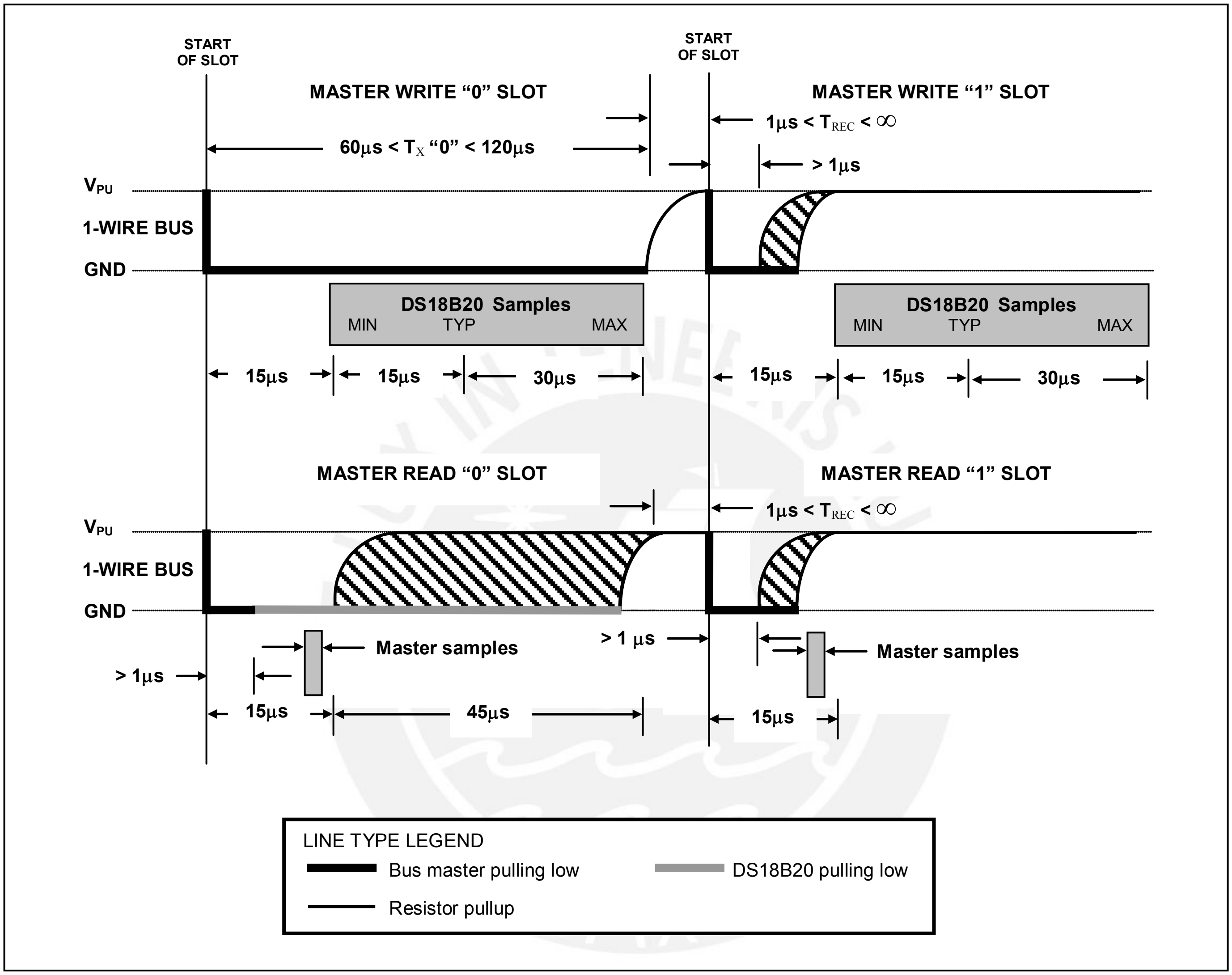
WRITE TIME SLOTS

There are two types of write time slots: "Write 1" time slots and "Write 0" time slots. The bus master uses a Write 1 time slot to write a logic 1 to the DS18B20 and a Write 0 time slot to write a logic 0 to the DS18B20. All write time slots must be a minimum of 60µs in duration with a minimum of a 1µs recovery time between individual write slots. Both types of write time slots are initiated by the master pulling the 1-Wire bus low (see Figure 14).

To generate a Write 1 time slot, after pulling the 1-Wire bus low, the bus master must release the 1-Wire bus within 15µs. When the bus is released, the 5kΩ pullup resistor will pull the bus high. To generate a Write 0 time slot, after pulling the 1-Wire bus low, the bus master must continue to hold the bus low for the duration of the time slot (at least 60µs).

The DS18B20 samples the 1-Wire bus during a window that lasts from 15µs to 60µs after the master initiates the write time slot. If the bus is high during the sampling window, a 1 is written to the DS18B20. If the line is low, a 0 is written to the DS18B20.

Figure 14. Read/Write Time Slot Timing Diagram



READ TIME SLOTS

The DS18B20 can only transmit data to the master when the master issues read time slots. Therefore, the master must generate read time slots immediately after issuing a Read Scratchpad [BEh] or Read Power Supply [B4h] command, so that the DS18B20 can provide the requested data. In addition, the master can generate read time slots after issuing Convert T [44h] or Recall E^2 [B8h] commands to find out the status of the operation as explained in the *DS18B20 Function Commands* section.

All read time slots must be a minimum of 60µs in duration with a minimum of a 1µs recovery time between slots. A read time slot is initiated by the master device pulling the 1-Wire bus low for a minimum of 1µs and then releasing the bus (see Figure 14). After the master initiates the read time slot, the DS18B20 will begin transmitting a 1 or 0 on bus. The DS18B20 transmits a 1 by leaving the bus high and transmits a 0 by pulling the bus low. When transmitting a 0, the DS18B20 will release the bus by the end of the time slot, and the bus will be pulled back to its high idle state by the pullup resister. Output data from the DS18B20 is valid for 15µs after the falling edge that initiated the read time slot. Therefore, the master must release the bus and then sample the bus state within 15µs from the start of the slot.

Figure 15 illustrates that the sum of T_{INIT}, T_{RC}, and T_{SAMPLE} must be less than 15µs for a read time slot. Figure 16 shows that system timing margin is maximized by keeping T_{INIT} and T_{RC} as short as possible and by locating the master sample time during read time slots towards the end of the 15µs period.

Figure 15. Detailed Master Read 1 Timing

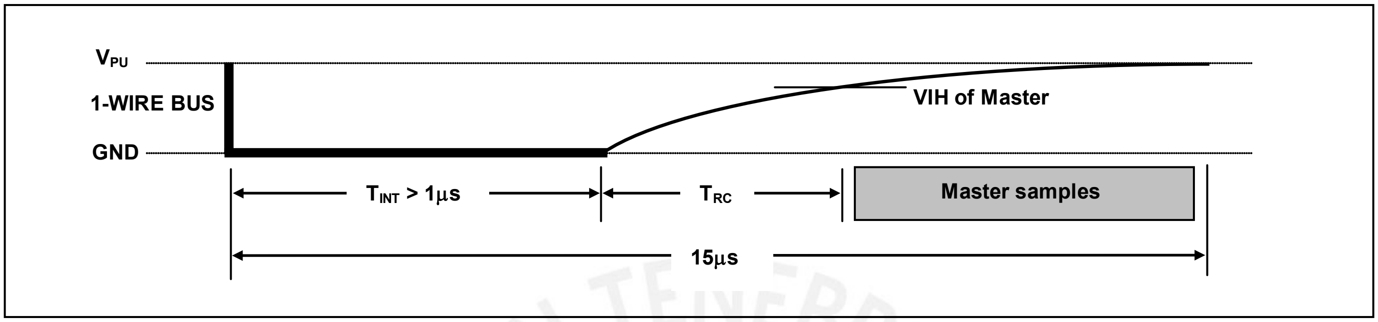
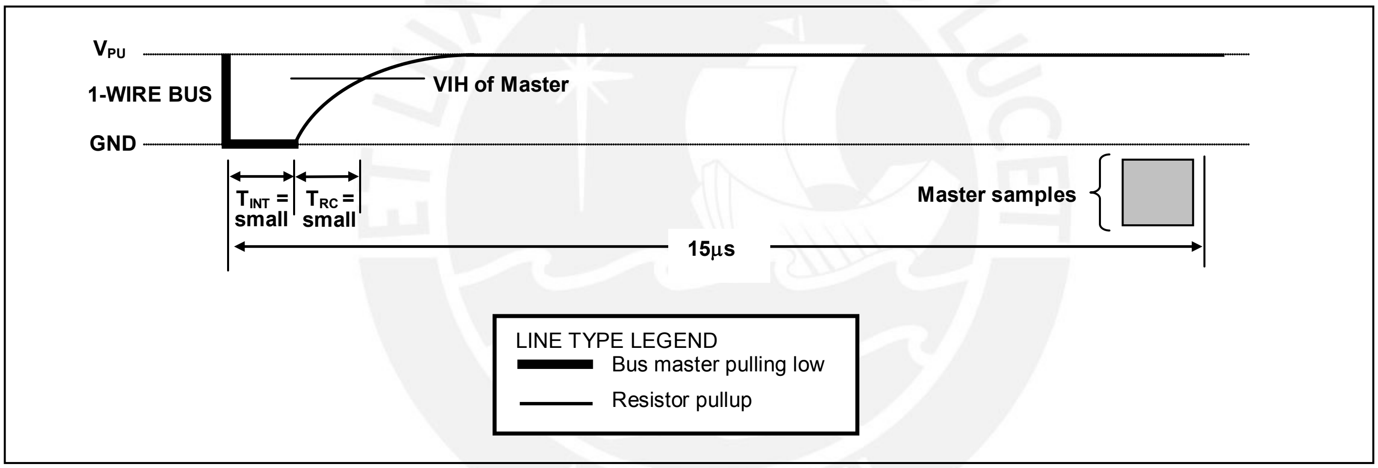


Figure 16. Recommended Master Read 1 Timing



RELATED APPLICATION NOTES

The following application notes can be applied to the DS18B20 and are available on our website at www.maxim-ic.com.

Application Note 27: Understanding and Using Cyclic Redundancy Checks with Maxim iButton Products
Application Note 122: Using Dallas' 1-Wire ICs in 1-Cell Li-Ion Battery Packs with Low-Side N-Channel Safety FETs Master
Application Note 126: 1-Wire Communication Through Software
Application Note 162: Interfacing the DS18x20/DS1822 1-Wire Temperature Sensor in a Microcontroller Environment
Application Note 208: Curve Fitting the Error of a Bandgap-Based Digital Temperature Sensor
Application Note 2420: 1-Wire Communication with a Microchip PICmicro Microcontroller
Application Note 3754: Single-Wire Serial Bus Carries Isolated Power and Data

Sample 1-Wire subroutines that can be used in conjunction with *Application Note 74: Reading and Writing iButtons via Serial Interfaces* can be downloaded from the Maxim website.

DS18B20 OPERATION EXAMPLE 1

In this example there are multiple DS18B20s on the bus and they are using parasite power. The bus master initiates a temperature conversion in a specific DS18B20 and then reads its scratchpad and recalculates the CRC to verify the data.

MASTER MODE	DATA (LSB FIRST)	COMMENTS
Tx	Reset	Master issues reset pulse.
Rx	Presence	DS18B20s respond with presence pulse.
Tx	55h	Master issues Match ROM command.
Tx	64-bit ROM code	Master sends DS18B20 ROM code.
Tx	44h	Master issues Convert T command.
Tx	DQ line held high by strong pullup	Master applies strong pullup to DQ for the duration of the conversion (t_{CONV}).
Tx	Reset	Master issues reset pulse.
Rx	Presence	DS18B20s respond with presence pulse.
Tx	55h	Master issues Match ROM command.
Tx	64-bit ROM code	Master sends DS18B20 ROM code.
Tx	BEh	Master issues Read Scratchpad command.
Rx	9 data bytes	Master reads entire scratchpad including CRC. The master then recalculates the CRC of the first eight data bytes from the scratchpad and compares the calculated CRC with the read CRC (byte 9). If they match, the master continues; if not, the read operation is repeated.

DS18B20 OPERATION EXAMPLE 2

In this example there is only one DS18B20 on the bus and it is using parasite power. The master writes to the T_H, T_L, and configuration registers in the DS18B20 scratchpad and then reads the scratchpad and recalculates the CRC to verify the data. The master then copies the scratchpad contents to EEPROM.

MASTER MODE	DATA (LSB FIRST)	COMMENTS
Tx	Reset	Master issues reset pulse.
Rx	Presence	DS18B20 responds with presence pulse.
Tx	CCh	Master issues Skip ROM command.
Tx	4Eh	Master issues Write Scratchpad command.
Tx	3 data bytes	Master sends three data bytes to scratchpad (T_H, T_L, and config).
Tx	Reset	Master issues reset pulse.
Rx	Presence	DS18B20 responds with presence pulse.
Tx	CCh	Master issues Skip ROM command.
Tx	BEh	Master issues Read Scratchpad command.
Rx	9 data bytes	Master reads entire scratchpad including CRC. The master then recalculates the CRC of the first eight data bytes from the scratchpad and compares the calculated CRC with the read CRC (byte 9). If they match, the master continues; if not, the read operation is repeated.
Tx	Reset	Master issues reset pulse.
Rx	Presence	DS18B20 responds with presence pulse.
Tx	CCh	Master issues Skip ROM command.
Tx	48h	Master issues Copy Scratchpad command.
Tx	DQ line held high by strong pullup	Master applies strong pullup to DQ for at least 10ms while copy operation is in progress.

ABSOLUTE MAXIMUM RATINGS

Voltage Range on Any Pin Relative to Ground ....-0.5V to +6.0V
Operating Temperature Range ....-55°C to +125°C
Storage Temperature Range..-55°C to +125°C
Solder Temperature ....Refer to the IPC/JEDEC J-STD-020 Specification.

These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

DC ELECTRICAL CHARACTERISTICS (-55°C to +125°C; V_{DD}=3.0V to 5.5V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Supply Voltage	V_{DD}	Local Power	+3.0		+5.5	V	1
Pullup Supply Voltage	V_{PU}	Parasite Power	+3.0		+5.5	V	1,2
		Local Power	+3.0		V_{DD}		
Thermometer Error	t_{ERR}	-10°C to +85°C			±0.5	°C	3
		-55°C to +125°C			±2		
Input Logic-Low	V_{IL}		-0.3		+0.8	V	1,4,5
Input Logic-High	V_{IH}	Local Power	+2.2		The lower of 5.5 or V_{DD} + 0.3	V	1, 6
		Parasite Power	+3.0				
Sink Current	I_L	$V_{I/O}$ = 0.4V	4.0			mA	1
Standby Current	I_{DDS}			750	1000	nA	7,8
Active Current	I_{DD}	V_{DD} = 5V		1	1.5	mA	9
DQ Input Current	I_{DQ}			5		µA	10
Drift				±0.2		°C	11

NOTES:

1) All voltages are referenced to ground.
2) The Pullup Supply Voltage specification assumes that the pullup device is ideal, and therefore the high level of the pullup is equal to V_{PU}. In order to meet the V_{IH} spec of the DS18B20, the actual supply rail for the strong pullup transistor must include margin for the voltage drop across the transistor when it is turned on; thus: $V_{PU\_ACTUAL} = V_{PU\_IDEAL} + V_{TRANSISTOR}$.
3) See typical performance curve in Figure 17.
4) Logic-low voltages are specified at a sink current of 4mA.
5) To guarantee a presence pulse under low voltage parasite power conditions, V_{ILMAX} may have to be reduced to as low as 0.5V.
6) Logic-high voltages are specified at a source current of 1mA.
7) Standby current specified up to +70°C. Standby current typically is 3µA at +125°C.
8) To minimize I_{DDS}, DQ should be within the following ranges: GND ≤ DQ ≤ GND + 0.3V or V_{DD} – 0.3V ≤ DQ ≤ V_{DD}.
9) Active current refers to supply current during active temperature conversions or EEPROM writes.
10) DQ line is high (“high-Z” state).
11) Drift data is based on a 1000-hour stress test at +125°C with V_{DD} = 5.5V.

AC ELECTRICAL CHARACTERISTICS—NV MEMORY

(-55°C to +100°C; V_{DD} = 3.0V to 5.5V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
NV Write Cycle Time	t_{WR}			2	10	ms
EEPROM Writes	N_{EEWR}	-55°C to +55°C	50k			writes
EEPROM Data Retention	t_{EEDR}	-55°C to +55°C	10			years

AC ELECTRICAL CHARACTERISTICS (-55°C to +125°C; V_{DD} = 3.0V to 5.5V)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Temperature Conversion Time	t_{CONV}	9-bit resolution			93.75	ms	1
		10-bit resolution			187.5		
		11-bit resolution			375		
		12-bit resolution			750		
Time to Strong Pullup On	t_{SPON}	Start Convert T Command Issued			10	µs	
Time Slot	t_{SLOT}		60		120	µs	1
Recovery Time	t_{REC}		1			µs	1
Write 0 Low Time	t_{LOW0}		60		120	µs	1
Write 1 Low Time	t_{LOW1}		1		15	µs	1
Read Data Valid	t_{RDV}				15	µs	1
Reset Time High	t_{RSTH}		480			µs	1
Reset Time Low	t_{RSTL}		480			µs	1,2
Presence-Detect High	t_{PDHIGH}		15		60	µs	1
Presence-Detect Low	t_{PDLOW}		60		240	µs	1
Capacitance	$C_{IN/OUT}$				25	pF	

NOTES:

1) See the timing diagrams in Figure 18.
2) Under parasite power, if t_{RSTL} > 960µs, a power-on reset may occur.

Figure 17. Typical Performance Curve

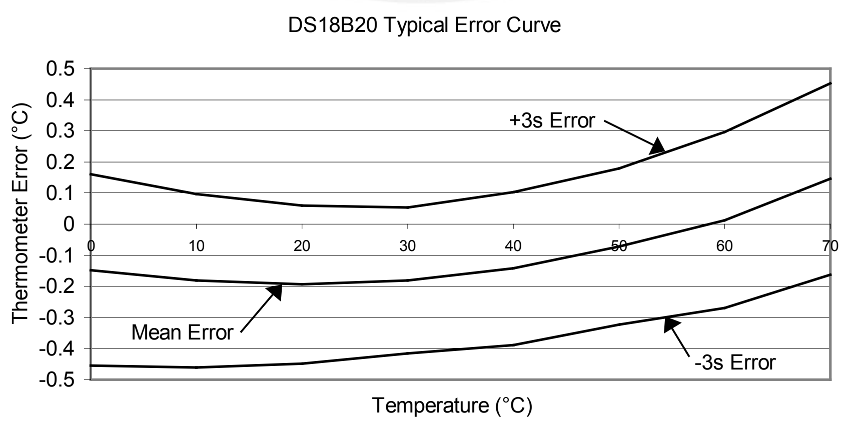
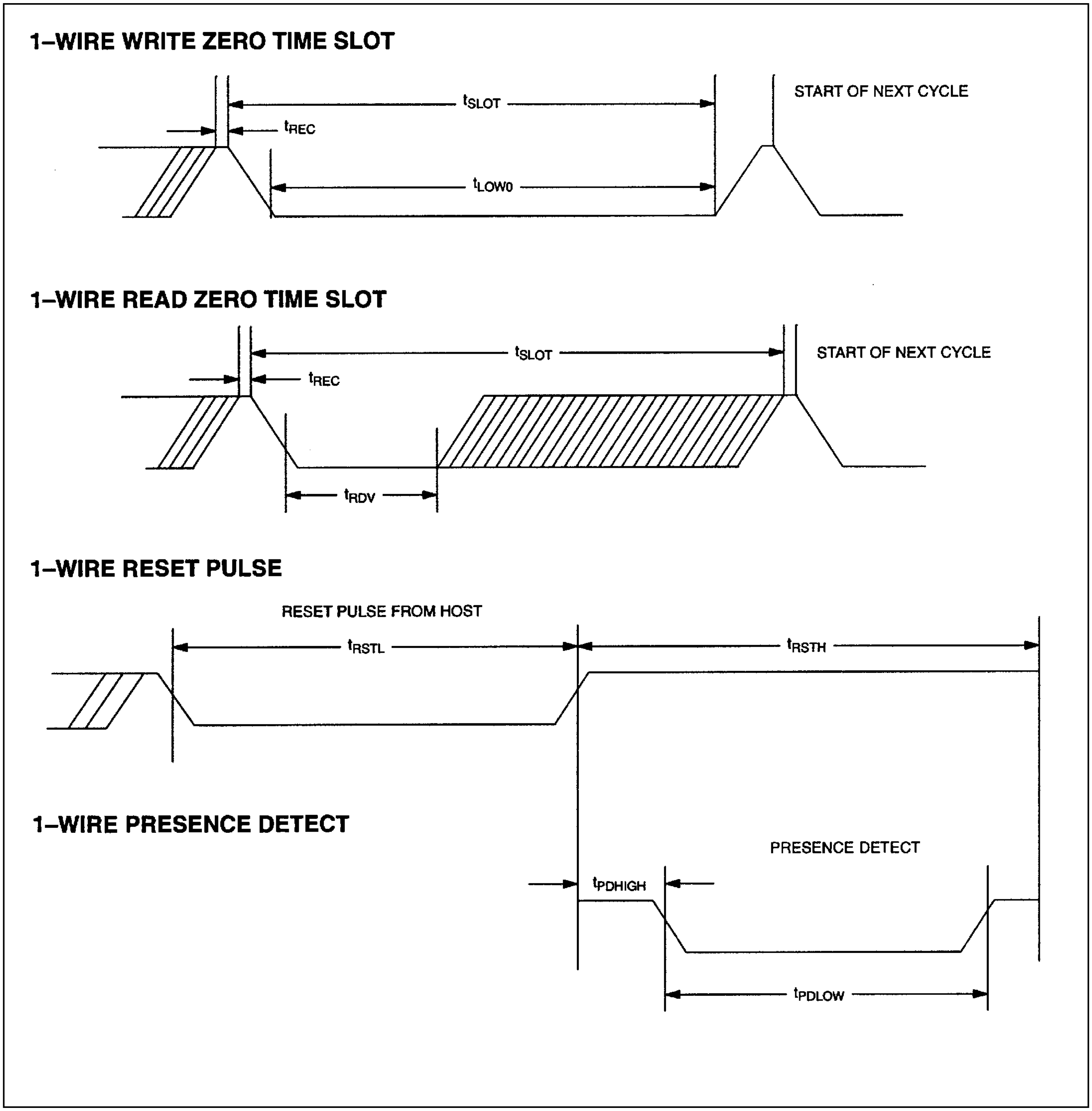


Figure 18. Timing Diagrams



REVISION HISTORY

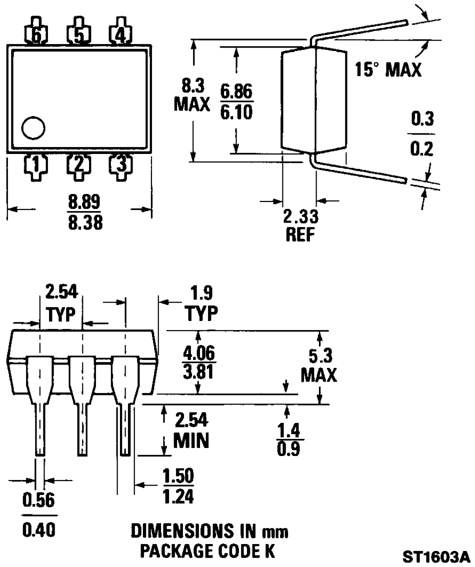
REVISION DATE	DESCRIPTION	PAGES CHANGED
030107	In the *Absolute Maximum Ratings* section, removed the reflow oven temperature value of +220°C. Reference to JEDEC specification for reflow remains.	19
101207	In the *Operation—Alarm Signaling* section, added "or equal to" in the desciption for a TH alarm condition	5
	In the *Memory* section, removed incorrect text describing memory.	7
	In the *Configuration Register* section, removed incorrect text describing configuration register.	8
042208	In the *Ordering Information* table, added TO-92 straight-lead packages and included a note that the TO-92 package in tape and reel can be ordered with either formed or straight leads.	2

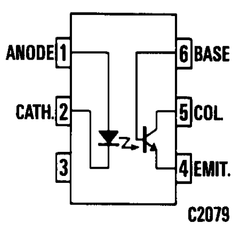
QT OPTOELECTRONICS

PHOTOTRANSISTOR OPTOCOUPLERS

4N35 4N36 4N37

PACKAGE DIMENSIONS





Equivalent Circuit

DESCRIPTION

The 4N35, 4N36, and 4N37 series of optocouplers have an NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode.

FEATURES & APPLICATIONS

- AC line/digital logic isolator
- Digital logic/digital logic isolator
- Telephone/telegraph line receiver
- Twisted pair line receiver
- High frequency power supply feedback control
- Relay contact monitor
- Power supply monitor
- Industrial controls
- Covered under UL component recognition program, reference File E90700
- High DC current transfer ratio

ABSOLUTE MAXIMUM RATINGS

TOTAL PACKAGE

*Relative humidity .... 85% @ 85°C
*Storage temperature .... −55°C to 150°C
*Operating temperature .... −55°C to 100°C
*Lead temperature (soldering, 10 sec) .... 260°C

INPUT DIODE

*Forward DC current (continuous) .... 60 mA
Reverse voltage .... 6 volts
*Peak forward current
(1 μs pulse, 300 pps) .... 3.0 A
*Power dissipation at T_A=25°C .... 100 mW†
*Power dissipation at T_C=25°C .... 100 mW†
(T_C indicates collector lead temp 1/32″ from case)

OUTPUT TRANSISTOR

*Power dissipation at 25°C ambient .... 300 mW
Derate linearly above 25°C .... 4 mW/°C
*Power dissipation at T_C=25°C .... 500 mW††
(T_C indicates collector lead temp 1/32″ from case)

*V_{CEO} .... 30 volts
*V_{CBO} .... 70 volts
*V_{ECO} .... 7 volts
*Collector current (continuous) .... 100 mA

*Indicates JEDEC registered values †Derate 1.33 mW/°C above 25°C. ††Derate 6.7 mW/°C above 25°C.

QT OPTOELECTRONICS

PHOTOTRANSISTOR OPTOCOUPLERS

ELECTRO-OPTICAL CHARACTERISTICS
(25°C Free Air Temperature Unless Otherwise Specified)

INDIVIDUAL COMPONENT CHARACTERISTICS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
INPUT DIODE						
*Forward voltage	V_F	.8		1.50	V	I_F=10 mA
*Forward voltage temp. coefficient	V_F	.9		1.7	V	I_F=10 mA, T_A=−55°C
*Forward voltage	V_F	.7		1.4	V	I_F=10 mA, T_A=+100°C
*Junction capacitance	C_J			100	pF	V_F=0 V, f=1 mHz
*Reverse leakage current			.01	10	μA	V_R=6.0 V
DETECTOR						
DC forward current gain	h_{FE}		250			V_{CE}=5 V, I_C=100 μA
*Collector to emitter breakdown voltage	BV_{CEO}	30	65		V	I_C=10 mA, I_F=0
*Collector to base breakdown voltage	BV_{CBO}	70	165		V	I_C=100 μA, I_F=0
*Emitter to collector breakdown voltage	BV_{ECO}	7	14		V	I_E=100 μA, I_F=0
Collector to emitter, leakage current	I_{CEO}		5	50	nA	V_{CE}=10 V, I_F=0
*Collector to emitter leakage current (dark)	I_{CEO}			500	μA	V_{CE}=30 V, I_F=0, T_A=100°C
Capacitance collector to emitter	C_{CEW}		8		pF	V_{CE}=0
Capacitance collector to base	C_{CBO}		20		pF	V_{CB}=10 V
Capacitance base to emitter	C_{BEO}		10		pF	V_{BE}=0

TRANSFER CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
COUPLED						
†*DC current transfer ratio	CTR	100			%	I_F=10 mA, V_{CE}=10 V
†*DC current transfer ratio	CTR	40			%	I_F=10 mA, V_{CE}=10 V, T_A=−55°C
†*DC current transfer ratio	CTR	40			%	I_F=10 mA, V_{CE}=10 V, T_A=+100°C
*Saturation voltage—collector to emitter	$V_{CE(SAT)}$			.3	volts	I_F=10 mA, I_C=0.5 mA

TRANSFER CHARACTERISTICS

AC CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
*Turn on time	t_{ON}		5	10	μsec	V_{CC}=10 V, I_C=2 mA, R_L=100Ω, (Fig. 10 and Fig. 11)
*Turn off time	t_{OFF}		5	10	μsec	V_{CC}=10 V, I_C=2 mA, R_L=100Ω, (Fig. 10 and Fig. 11)

*Indicates JEDEC registered values
†Pulse test: pulse width=300μS,
duty cycle≤2.0%

ELECTRO-OPTICAL CHARACTERISTICS
(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

ISOLATION CHARACTERISTICS

CHARACTERISTICS	SYMBOL	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
Isolation voltage all devices	V_{ISO}	5300			V_{RMS}	$I_{I-O} \leq 1\mu A$ t=1 minute
*Input to output isolation current (pulse width=8 msec) (see Note 1)	I_{I-O}					
4N35				100	μA	V_{iso}=3550 VAC (peak)
4N36				100	μA	V_{iso}=2500 VAC (peak)
4N37				100	μA	V_{iso}=1500 VAC (peak)
*Input to output resistance	R_{I-O}	100			gigaohms	Input to output voltage= 500 V (see Note 1)
*Input to output capacitance	C_{I-O}			2.5	picofarads	Input to output voltage= O V, f=1 MHz (see Note 1)

*Indicates JEDEC registered values
†Pulse test: pulse width=300μS, duty cycle≤2.0%

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified)

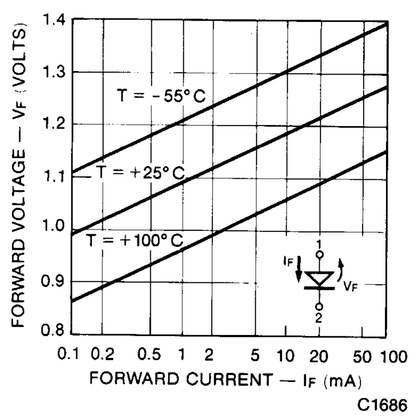


Fig. 1. Forward Voltage vs. Current

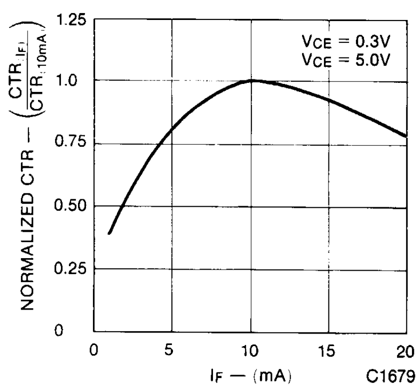


Fig. 2. Normalized CTR vs. Forward Current

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES

(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

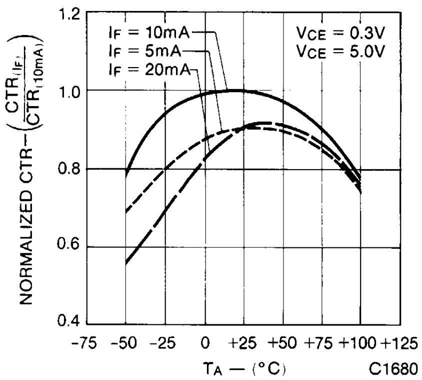


Fig. 3. Normalized CTR vs. Temperature

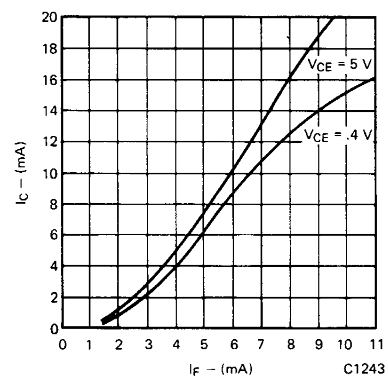


Fig. 4. Collector Current vs. Forward Current

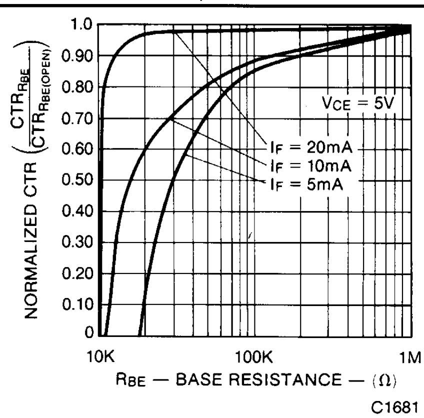


Fig. 5. CTR vs. RBE (Unsaturated)

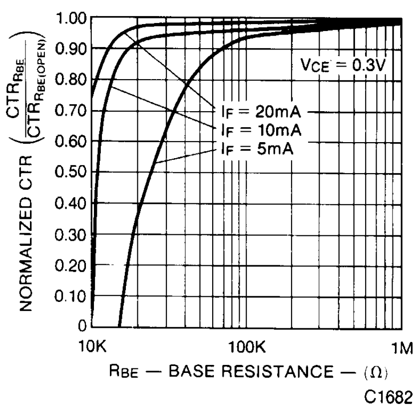


Fig. 6. CTR vs. RBE (Saturated)

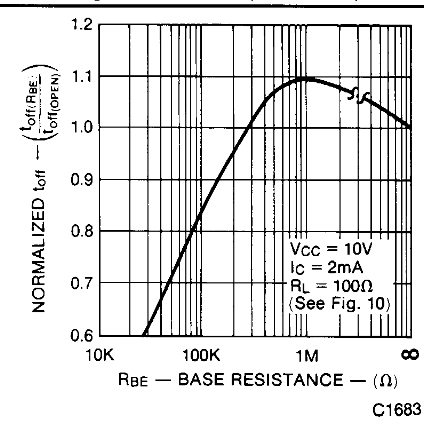


Fig. 7. Normalized T_{OFF} vs. RBE

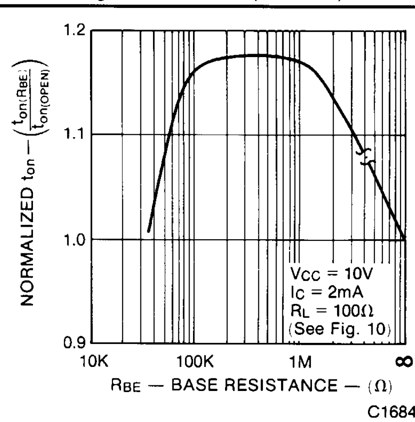


Fig. 8. Normalized T_{ON} vs. RBE

TYPICAL ELECTRO-OPTICAL CHARACTERISTIC CURVES
(25°C Free Air Temperature Unless Otherwise Specified) (Cont'd)

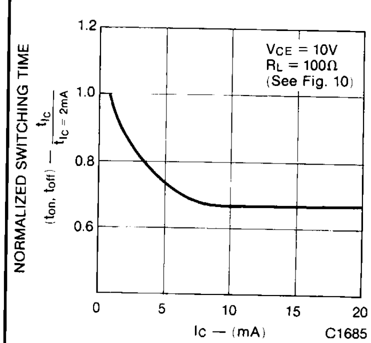


Fig. 9. Switching Time vs. IC

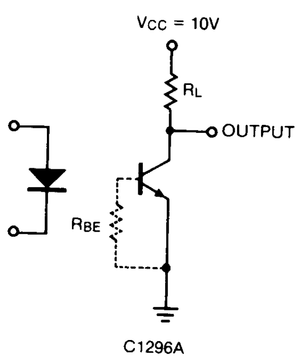


Fig. 10. Switching Time Test Circuit

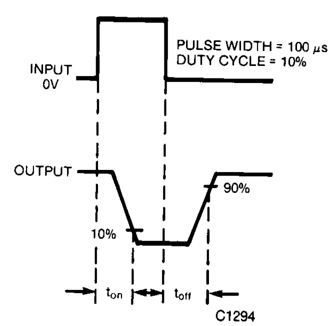


Fig. 11. Switching Time Waveforms

NOTES

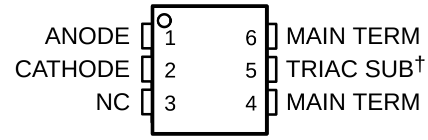
1. Tests of input to output isolation current resistance and capacitance are performed with the input terminals (diode) shorted together and the output terminals (transistor) shorted together.
2. The current transfer ratio (I_C/I_F) is the ratio of the detector collector current to the LED input current with V_{CE} at 10 volts.
3. Rise time (t_r) is the time required for the collector current to increase from 10% of its final value, to 90%. Fall time (t_f) is the time required for the collector current to decrease from 90% of its initial value to 10%.

MOC3020 THRU MOC3023 OPTOCOUPLERS/OPTOISOLATORS

SOES025 – OCTOBER 1986 – REVISED OCTOBER 1995

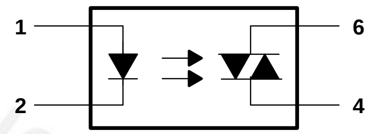
- **250 V Phototriac Driver Output**
- **Gallium-Arsenide-Diode Infrared Source and Optically-Coupled Silicon Traic Driver (Bilateral Switch)**
- **UL Recognized . . . File Number E65085**
- **High Isolation . . . 7500 V Peak**
- **Output Driver Designed for 220 V ac**
- **Standard 6-Terminal Plastic DIP**
- **Directly Interchangeable with Motorola MOC3020, MOC3021, MOC3022, and MOC3023**
- **Direct Replacements for:**
  - **TRW Optron OPI3020, OPI3021, OPI3022, and OPI3023;**
  - **General Instrument MCP3020, MCP3021, and MCP3022;**
  - **General Electric GE3020, GE3021, GE3022, and GE3023**

MOC3020 – MOC3023 . . . PACKAGE
(TOP VIEW)



† Do not connect this terminal
NC – No internal connection

logic diagram



absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)†

Input-to-output peak voltage, 5 s maximum duration, 60 Hz (see Note 1)	7.5 kV
Input diode reverse voltage	3 V
Input diode forward current, continuous	50 mA
Output repetitive peak off-state voltage	400 V
Output on-state current, total rms value (50-60 Hz, full sine wave): T_A = 25°C	100 mA
T_A = 70°C	50 mA
Output driver nonrepetitive peak on-state current (t_w = 10 ms, duty cycle = 10%, see Figure 7)	1.2 A
Continuous power dissipation at (or below) 25°C free-air temperature:	
Infrared-emitting diode (see Note 2)	100 mW
Phototriac (see Note 3)	300 mW
Total device (see Note 4)	330 mW
Operating junction temperature range, T_J	–40°C to 100°C
Storage temperature range, T_{stg}	–40°C to 150°C
Lead temperature 1,6 (1/16 inch) from case for 10 seconds	260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

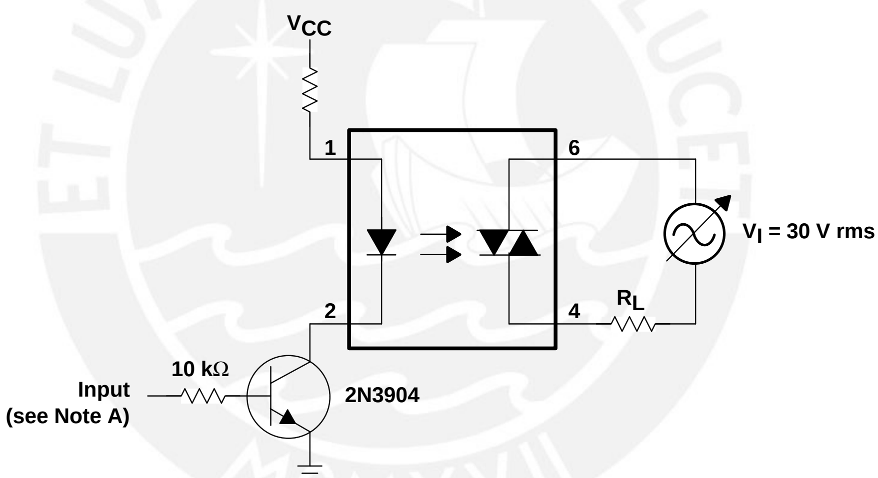
NOTES: 1. Input-to-output peak voltage is the internal device dielectric breakdown rating.
2. Derate linearly to 100°C free-air temperature at the rate of 1.33 mW/°C.
3. Derate linearly to 100°C free-air temperature at the rate of 4 mW/°C.
4. Derate linearly to 100°C free-air temperature at the rate of 4.4 mW/°C.

electrical characteristics at 25°C free-air temperature (unless otherwise noted)

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_R	Static reverse current		V_R = 3 V		0.05	100	µA
V_F	Static forward voltage		I_F = 10 mA		1.2	1.5	V
$I_{(DRM)}$	Repetitive off-state current, either direction		$V_{(DRM)}$ = 400 V, See Note 5		10	100	nA
dv/dt	Critical rate of rise of off-state voltage		See Figure 1		100		V/µs
dv/dt(c)	Critical rate of rise of commutating voltage		I_O = 15 mA, See Figure 1		0.15		V/µs
I_{FT}	Input trigger current, either direction	MOC3020	Output supply voltage = 3 V		15	30	mA
		MOC3021			8	15	
		MOC3022			5	10	
		MOC3023			3	5	
V_{TM}	Peak on-state voltage, either direction		I_{TM} = 100 mA		1.4	3	V
I_H	Holding current, either direction				100		µA

NOTE 5: Test voltage must be applied at a rate no higher than 12 V/µs.

PARAMETER MEASUREMENT INFORMATION



NOTE A. The critical rate of rise of off-state voltage, dv/dt, is measured with the input at 0 V. The frequency of V_{in} is increased until the phototriac turns on. This frequency is then used to calculate the dv/dt according to the formula:

$$dv/dt = 2\sqrt{2\pi f V_{in}}$$

The critical rate of rise of commutating voltage, dv/dt(c), is measured by applying occasional 5-V pulses to the input and increasing the frequency of V_{in} until the phototriac stays on (latches) after the input pulse has ceased. With no further input pulses, the frequency of V_{in} is then gradually decreased until the phototriac turns off. The frequency at which turn-off occurs may then be used to calculate the dv/dt(c) according to the formula shown above.

Figure 1. Critical Rate of Rise Test Circuit

TYPICAL CHARACTERISTICS

EMITTING-DIODE TRIGGER CURRENT (NORMALIZED)
vs
FREE-AIR TEMPERATURE

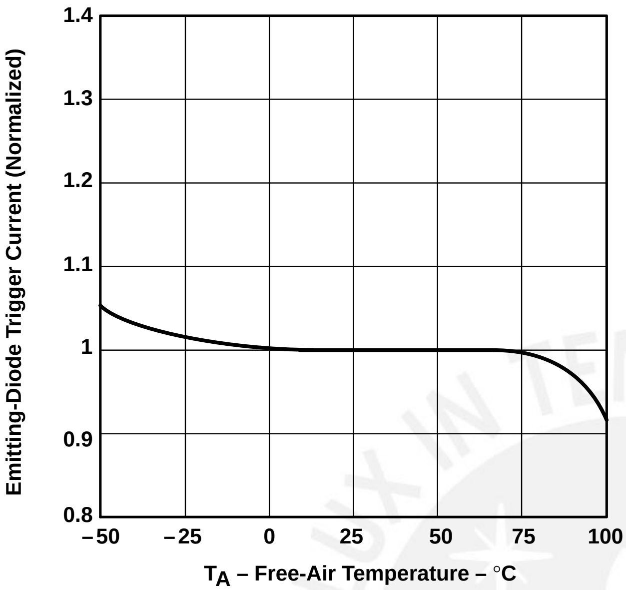


Figure 2

ON-STATE CHARACTERISTICS

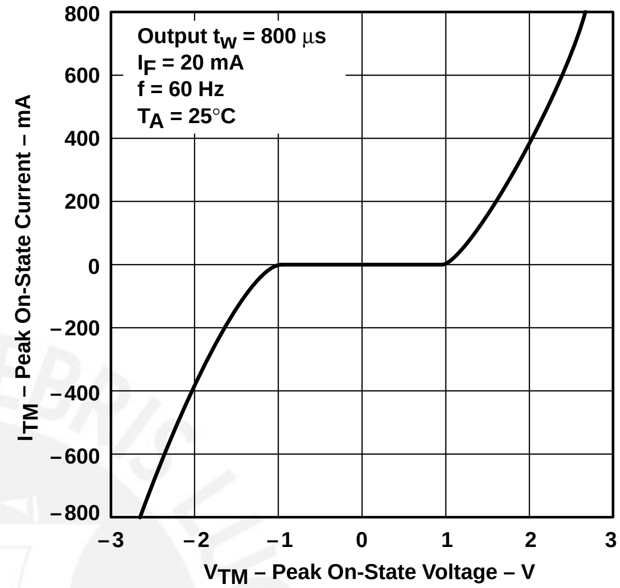


Figure 3

NONREPETITIVE PEAK ON-STATE CURRENT
vs
PULSE DURATION

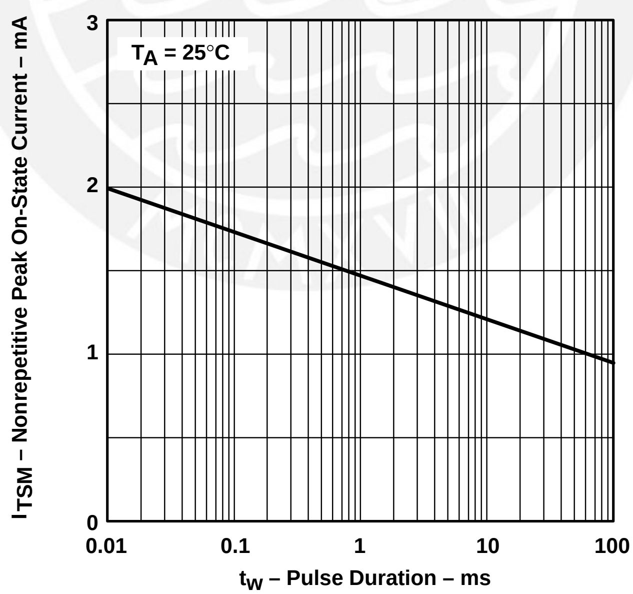


Figure 4

APPLICATIONS INFORMATION

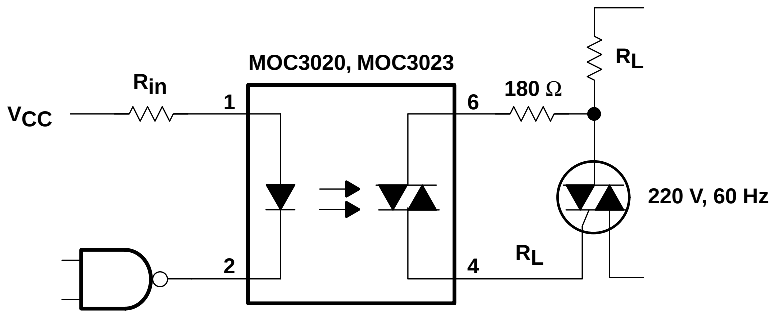


Figure 5. Resistive Load

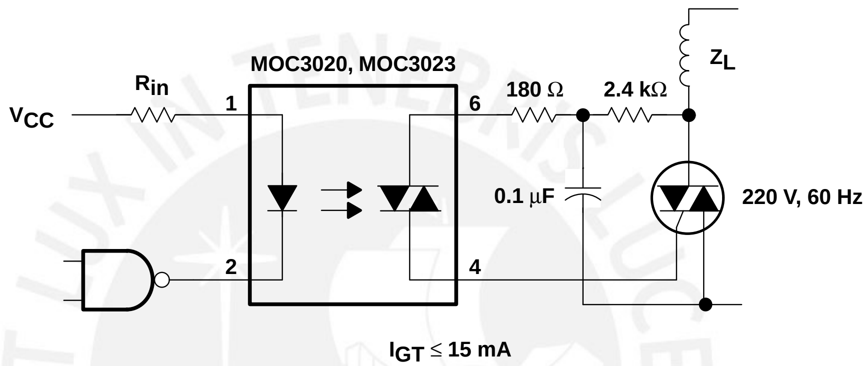


Figure 6. Inductive Load With Sensitive-Gate Triac

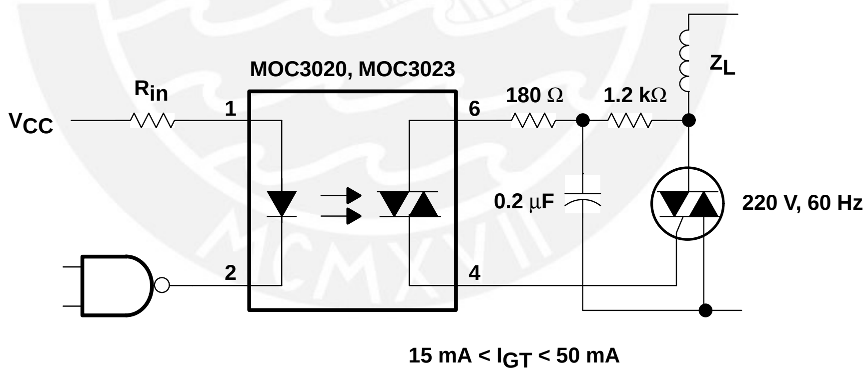
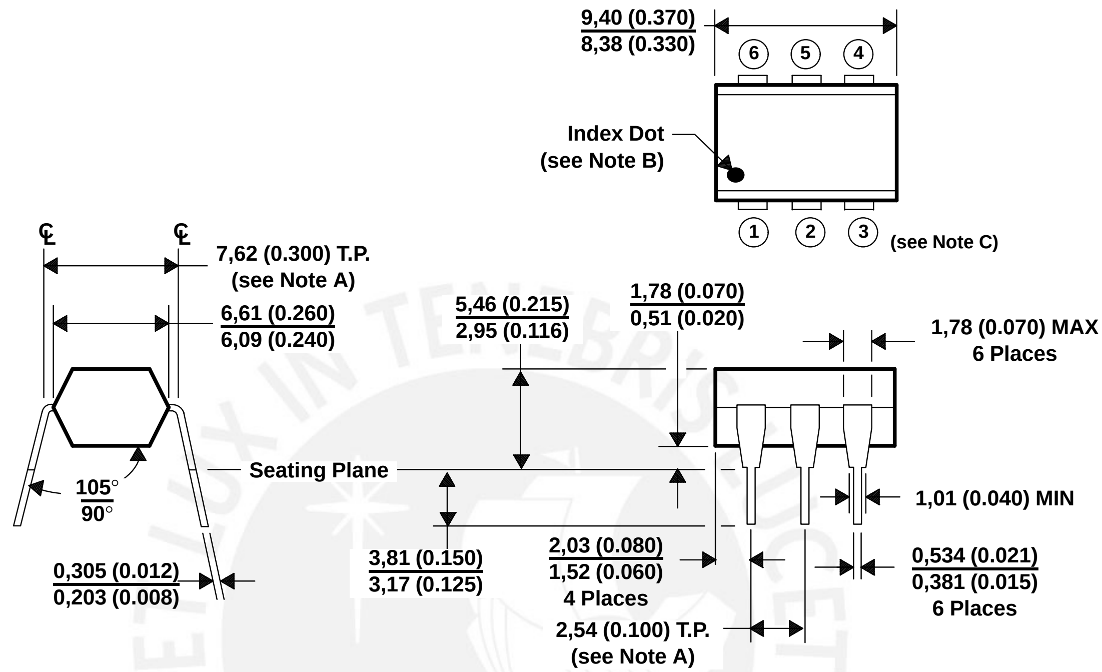


Figure 7. Inductive Load With Nonsensitive-Gate Triac

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

MECHANICAL INFORMATION

Each device consists of a gallium-arsenide infrared-emitting diode optically coupled to a silicon phototriac mounted on a 6-terminal lead frame encapsulated within an electrically nonconductive plastic compound. The case can withstand soldering temperature with no deformation and device performance characteristics remain stable when operated in high-humidity conditions.



NOTES: A. Leads are within 0,13 (0.005) radius of true position (T.P.) with maximum material condition and unit installed.
B. Pin 1 identified by index dot.
C. Terminal connections:
1. Anode (part of the infrared-emitting diode)
2. Cathode (part of the infrared-emitting diode)
3. No internal connection
4. Main terminal (part of the phototransistor)
5. Triac Substrate (DO NOT connect) (part of the phototransistor)
6. Main terminal (part of the phototransistor)
D. The dimensions given fall within JEDEC MO-001 AM dimensions.
E. All linear dimensions are given in millimeters and parenthetically given in inches.

Figure 8. Mechanical Information

IMPORTANT NOTICE

Texas Instruments (TI) reserves the right to make changes to its products or to discontinue any semiconductor product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

TI warrants performance of its semiconductor products and related software to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Certain applications using semiconductor products may involve potential risks of death, personal injury, or severe property or environmental damage ("Critical Applications").

TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS.

Inclusion of TI products in such applications is understood to be fully at the risk of the customer. Use of TI products in such applications requires the written approval of an appropriate TI officer. Questions concerning potential risk applications should be directed to TI through a local SC sales office.

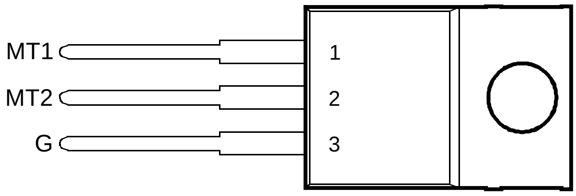
In order to minimize risks associated with the customer's applications, adequate design and operating safeguards should be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein. Nor does TI warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used.

JULY 1975 - REVISED MARCH 1997

- **Sensitive Gate Triacs**
- **8 A RMS, 70 A Peak**
- **Glass Passivated Wafer**
- **400 V to 800 V Off-State Voltage**
- **Max I_{GT} of 5 mA (Quadrant 1)**

TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDC2ACA

absolute maximum ratings over operating case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (see Note 1)	TIC225D	V_{DRM}	400	V
	TIC225M		600	
	TIC225S		700	
	TIC225N		800	
Full-cycle RMS on-state current at (or below) 70°C case temperature (see Note 2)		$I_{T(RMS)}$	8	A
Peak on-state surge current full-sine-wave (see Note 3)		I_{TSM}	70	A
Peak on-state surge current half-sine-wave (see Note 4)		I_{TSM}	80	A
Peak gate current		I_{GM}	±1	A
Peak gate power dissipation at (or below) 85°C case temperature (pulse width ≤ 200 µs)		P_{GM}	2.2	W
Average gate power dissipation at (or below) 85°C case temperature (see Note 5)		$P_{G(AV)}$	0.9	W
Operating case temperature range		T_C	-40 to +110	°C
Storage temperature range		T_{stg}	-40 to +125	°C
Lead temperature 1.6 mm from case for 10 seconds		T_L	230	°C

NOTES:
1. These values apply bidirectionally for any value of resistance between the gate and Main Terminal 1.
2. This value applies for 50-Hz full-sine-wave operation with resistive load. Above 70°C derate linearly to 110°C case temperature at the rate of 200 mA/°C.
3. This value applies for one 50-Hz full-sine-wave when the device is operating at (or below) the rated value of on-state current. Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
4. This value applies for one 50-Hz half-sine-wave when the device is operating at (or below) the rated value of on-state current. Surge may be repeated after the device has returned to original thermal equilibrium. During the surge, gate control may be lost.
5. This value applies for a maximum averaging time of 20 ms.

electrical characteristics at 25°C case temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off-state current	V_D = rated V_{DRM}	$I_G = 0$	T_C = 110°C			±2	mA
I_{GTM}	Peak gate trigger current	V_{supply} = +12 V†	R_L = 10 Ω	$t_{p(g)}$ > 20 µs		0.8	5	mA
		V_{supply} = +12 V†	R_L = 10 Ω	$t_{p(g)}$ > 20 µs		-4.5	-20	
		V_{supply} = -12 V†	R_L = 10 Ω	$t_{p(g)}$ > 20 µs		-3.5	-10	
		V_{supply} = -12 V†	R_L = 10 Ω	$t_{p(g)}$ > 20 µs		11.7	30	
V_{GTM}	Peak gate trigger voltage	V_{supply} = +12 V†	R_L = 10 Ω	$t_{p(g)}$ > 20 µs		0.7	2	V
		V_{supply} = +12 V†	R_L = 10 Ω	$t_{p(g)}$ > 20 µs		-0.7	-2	
		V_{supply} = -12 V†	R_L = 10 Ω	$t_{p(g)}$ > 20 µs		-0.8	-2	
		V_{supply} = -12 V†	R_L = 10 Ω	$t_{p(g)}$ > 20 µs		0.9	2	

† All voltages are with respect to Main Terminal 1.

electrical characteristics at 25°C case temperature (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V_{TM}	Peak on-state voltage	I_{TM} = ±12 A	I_G = 50 mA	(see Note 6)		±1.6	±2.1	V
I_H	Holding current	V_{supply} = +12 V† V_{supply} = -12 V†	I_G = 0 I_G = 0	Init' I_{TM} = 100 mA Init' I_{TM} = -100 mA		3 -4.7	20 -20	mA
I_L	Latching current	V_{supply} = +12 V† V_{supply} = -12 V†	(see Note 7)				30 -30	mA
dv/dt	Critical rate of rise of off-state voltage	V_{DRM} = Rated V_{DRM}	I_G = 0	T_C = 110°C		±50		V/µs
$dv/dt_{(c)}$	Critical rise of commutation voltage	V_{DRM} = Rated V_{DRM}	I_{TRM} = ±12 A	T_C = 70°C	±1	±1.5	±4.5	V/µs

† All voltages are with respect to Main Terminal 1.

NOTES: 6. This parameter must be measured using pulse techniques, t_p = ≤ 1 ms, duty cycle ≤ 2 %. Voltage-sensing contacts separate from the current carrying contacts are located within 3.2 mm from the device body.

7. The triacs are triggered by a 15-V (open-circuit amplitude) pulse supplied by a generator with the following characteristics: R_G = 100 Ω, $t_{p(g)}$ = 20 µs, t_r = ≤ 15 ns, f = 1 kHz

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{θJC}$	Junction to case thermal resistance			2.5	°C/W
$R_{θJA}$	Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS

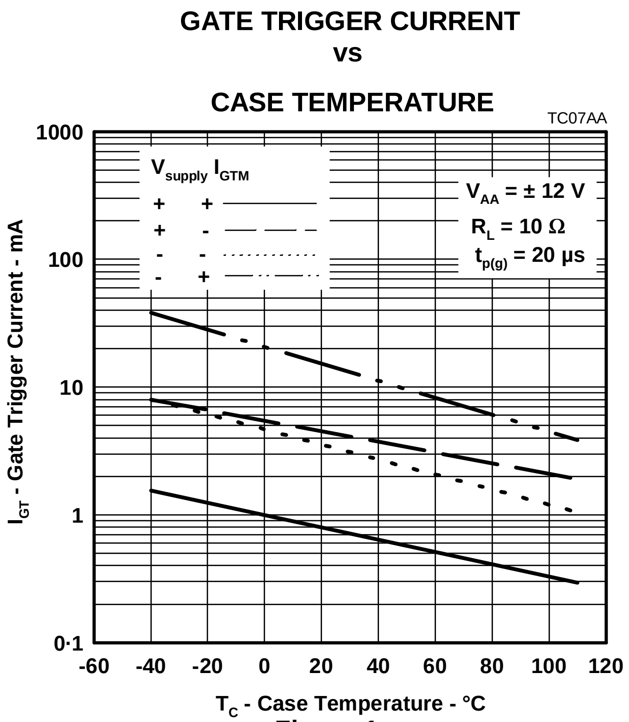


Figure 1.

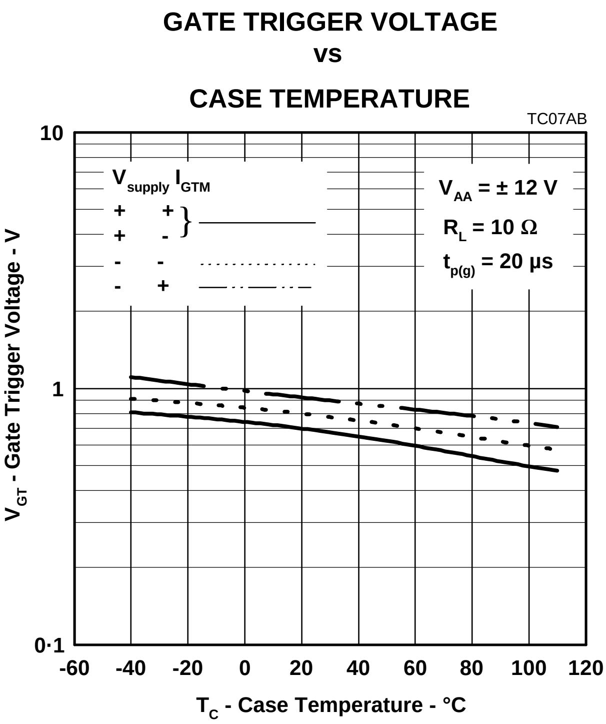


Figure 2.

TYPICAL CHARACTERISTICS

HOLDING CURRENT vs CASE TEMPERATURE

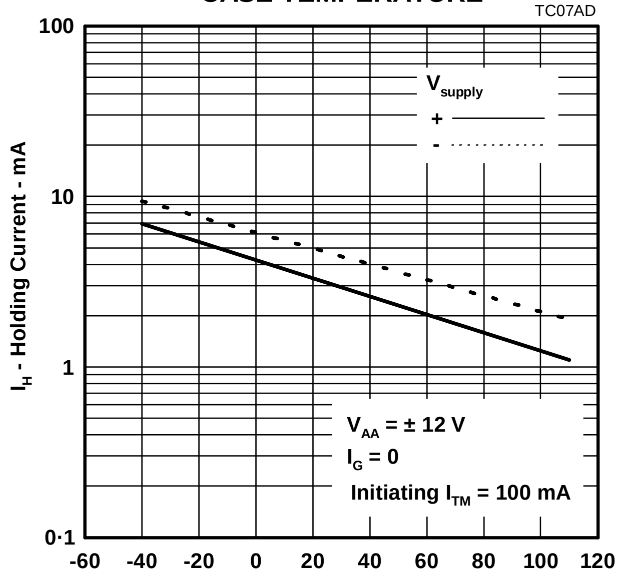


Figure 3.

GATE FORWARD VOLTAGE vs GATE FORWARD CURRENT

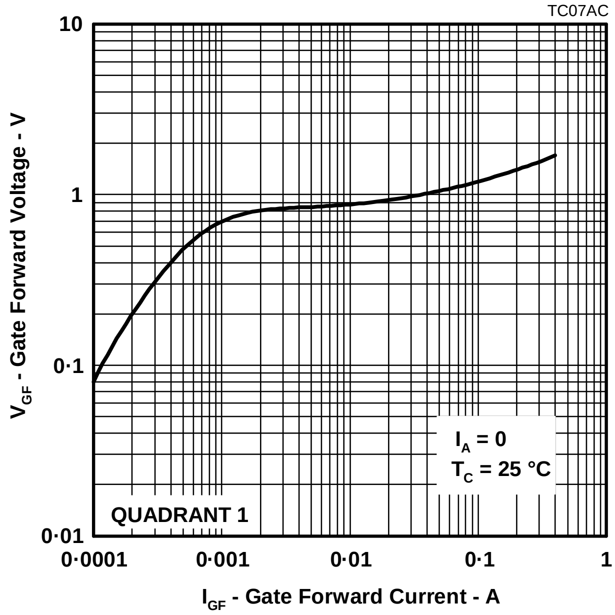


Figure 4.

LATCHING CURRENT vs CASE TEMPERATURE

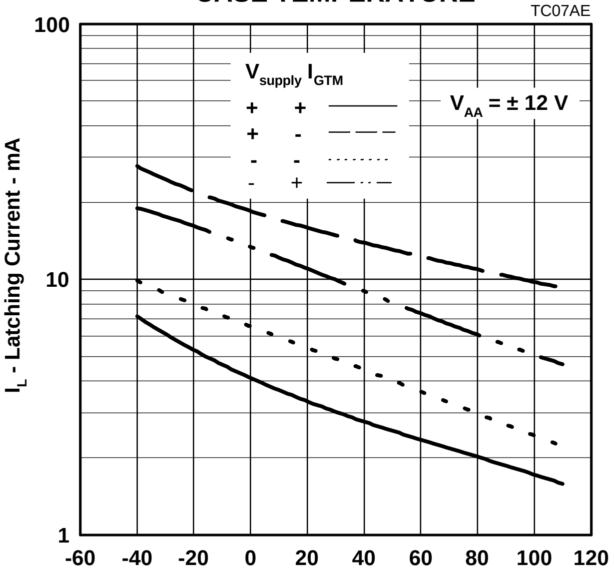


Figure 5.

SURGE ON-STATE CURRENT vs CYCLES OF CURRENT DURATION

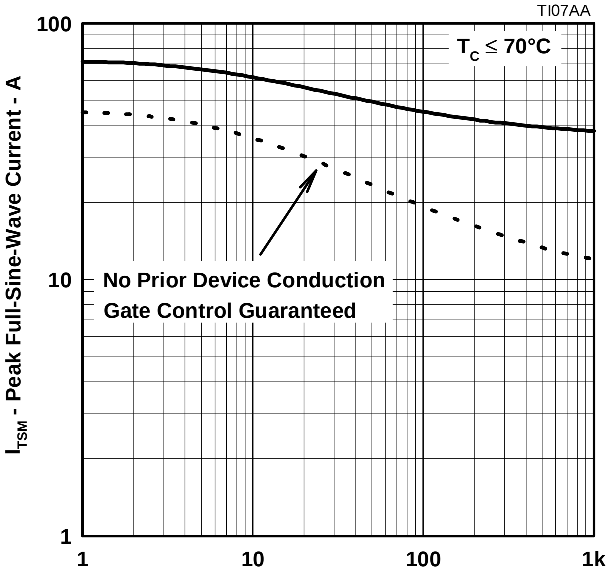


Figure 6.

TYPICAL CHARACTERISTICS

MAXIMUM RMS ON-STATE CURRENT vs CASE TEMPERATURE

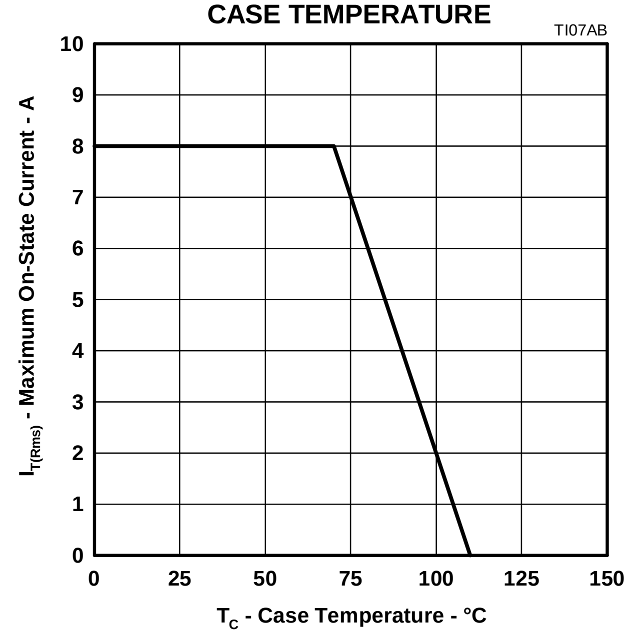
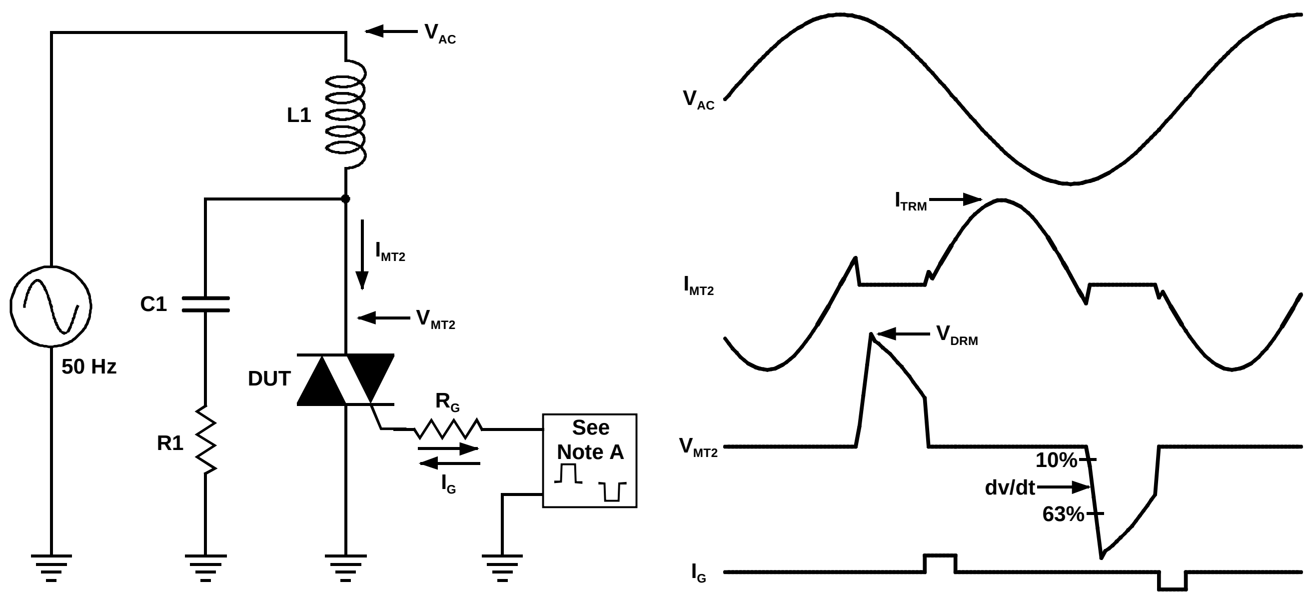


Figure 7.

PARAMETER MEASUREMENT INFORMATION



NOTE A: The gate-current pulse is furnished by a trigger circuit which presents essentially an open circuit between pulses. The pulse is timed so that the off-state-voltage duration is approximately 800 µs.

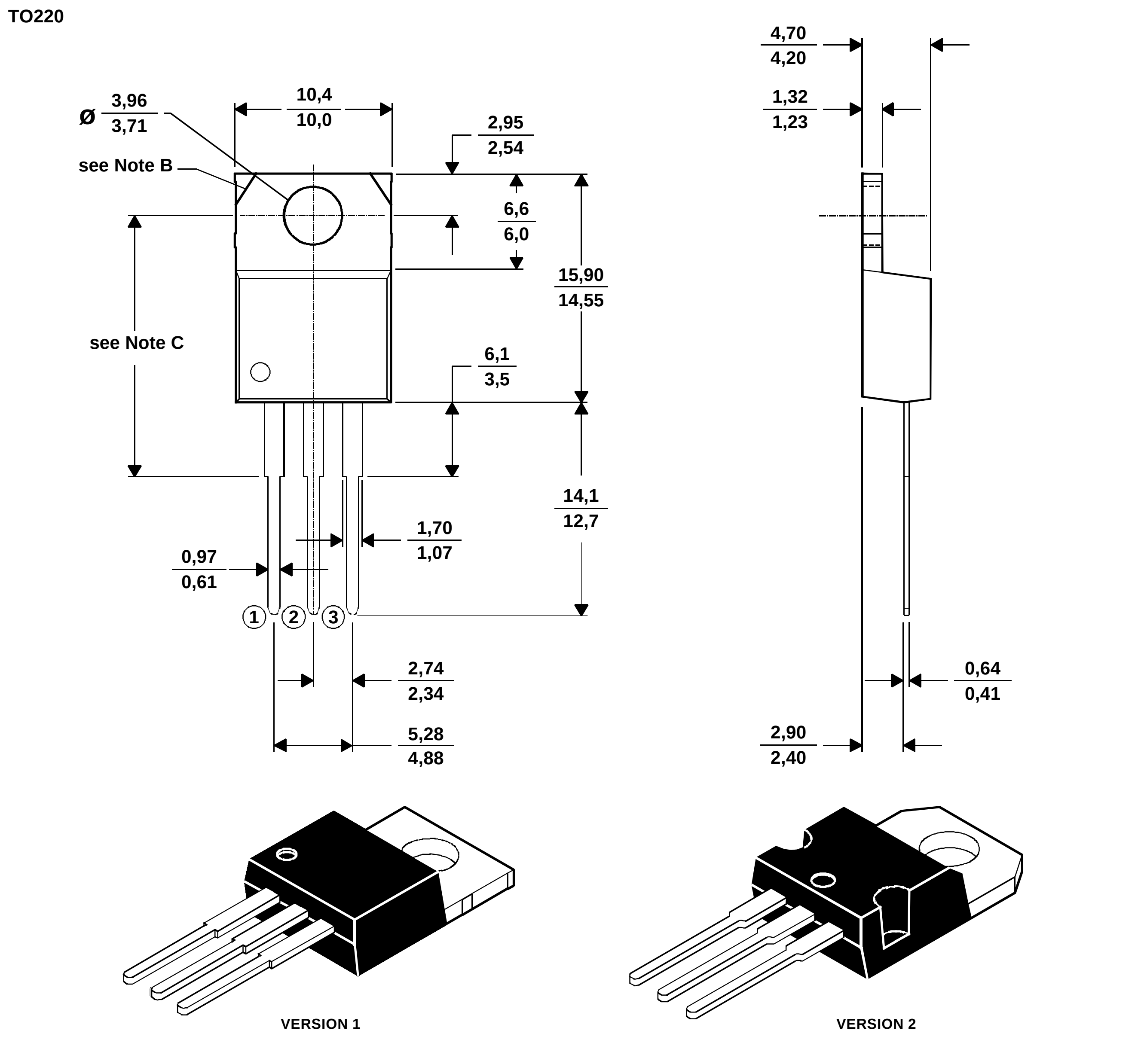
PMC2AA

Figure 8.

MECHANICAL DATA

TO-220
3-pin plastic flange-mount package

This single-in-line package consists of a circuit mounted on a lead frame and encapsulated within a plastic compound. The compound will withstand soldering temperature with no deformation, and circuit performance characteristics will remain stable when operated in high humidity conditions. Leads require no additional cleaning or processing when used in soldered assembly.



ALL LINEAR DIMENSIONS IN MILLIMETERS

MDXXBE

NOTES: A. The centre pin is in electrical contact with the mounting tab.
B. Mounting tab corner profile according to package version.
C. Typical fixing hole centre stand off height according to package version.
Version 1, 18.0 mm. Version 2, 17.6 mm.

IMPORTANT NOTICE

Power Innovations Limited (PI) reserves the right to make changes to its products or to discontinue any semiconductor product or service without notice, and advises its customers to verify, before placing orders, that the information being relied on is current.

PI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with PI's standard warranty. Testing and other quality control techniques are utilized to the extent PI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except as mandated by government requirements.

PI accepts no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein. Nor is any license, either express or implied, granted under any patent right, copyright, design right, or other intellectual property right of PI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used.

PI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS.

Desclasifación por efectos de la altura

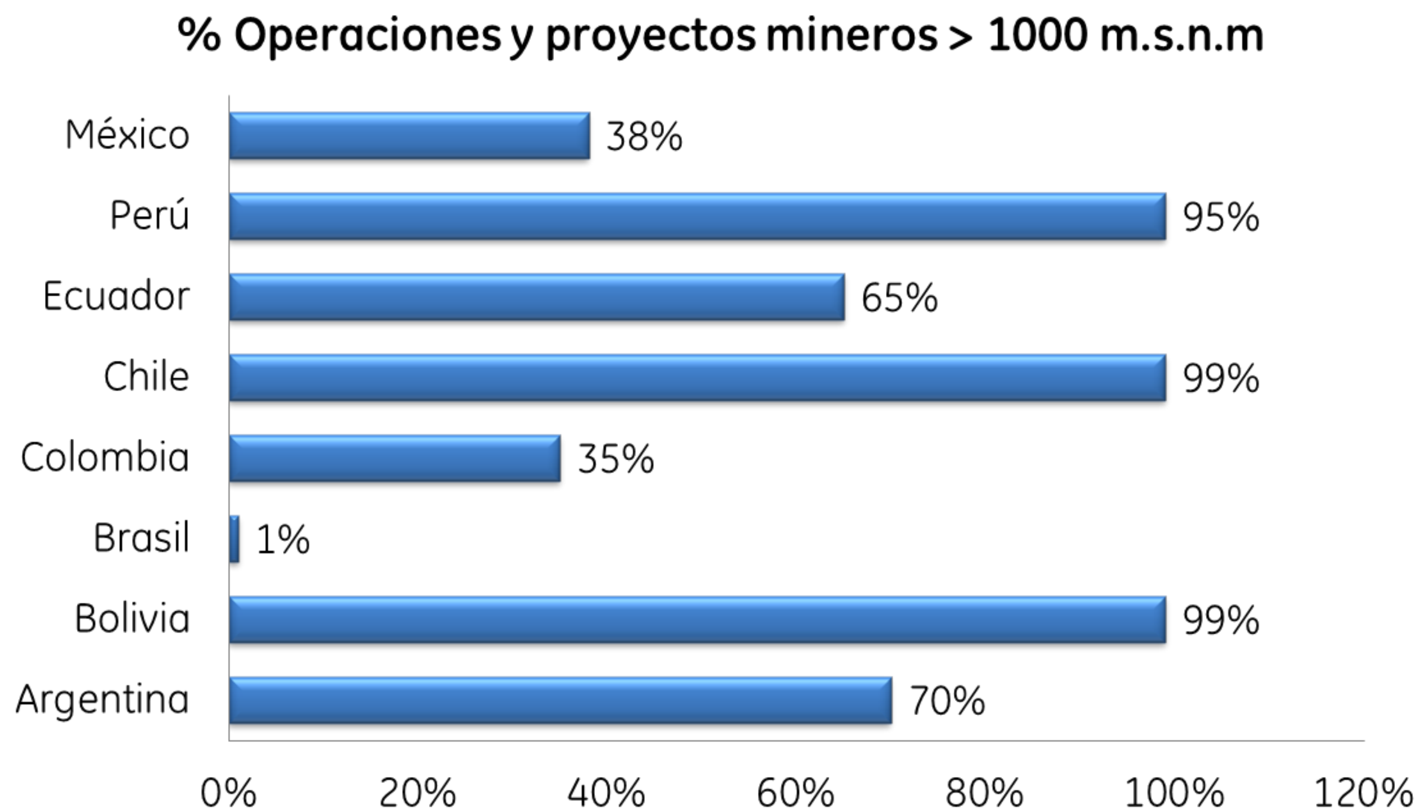
Switchgear Media Tensión
AIS (Air Insulation Switchgear)

Dany Huamán
Ingeniero Especificador

imagination at work

Minería en Centro y Latinoamérica

- América Latina se caracteriza por condiciones geográficas de gran altitud, la cual obliga a considerar factores de corrección en el diseño eléctrico y selección de equipos.



Fuente: Estimación GE Mining 2013

Switchgear MT según IEC / ANSI

- Las condiciones normales de operación han sido definidas por los estándares de construcción IEC y ANSI.
- Para condiciones inusuales de funcionamiento los estándares recomiendan el uso de factores de corrección.

Tabla : Condiciones normales de operación

Estándar	IEC IEC 62271-200	ANSI IEEE C37.20.2
Temperatura		
Ambiente instantáneo 0°C		
Mínimo	-5 °C	-30 °C
Máximo	+40 °C	+40 °C
Valor máximo promedio diario	+35 °C	No especifica
Altitud		
Altitud maxima (metros)	≤ 1000	≤ 1000
Radiación Solar		
Radiación Solar	No específica	No significativa ANSI Std C37.24-1986
Humedad		
Promedio relativo de humedad respecto a un periodo		(*)
24 horas	95%	No específica
01 mes	90%	No específica

Fuente: Factores de corrección de los rangos eléctricos para switchgear de media tensión aislado en aire por altitud de operación

imagination at work

Condiciones atmosféricas

- La altura modifica las propiedades dieléctricas de los rangos eléctricos de funcionamiento de los switchgear debido a la reducción de la densidad de aire.

- La rotura del nivel de aislamiento de voltaje depende de las condiciones atmosféricas, la cual es medida en condiciones de prueba (temperatura t, presión b, humedad d) de acuerdo al estándar IEC 60-1.

- La rotura del nivel de aislamiento de voltaje es proporcional al factor de corrección atmosférico Kt que es el resultado de los factores:

$$Kt = k1 \,.\, K2 \qquad U = U0 \,.\, Kt$$

  - Factor de corrección por densidad de aire, K1

    $K1 = \delta^m$, δ = densidad de aire

$$\delta = \frac{b}{b_0}\,\frac{273 + t_0}{273 + t}$$

  - Factor de corrección por humedad, K2

imagination at work

Desclasificación por altura

- La disminución de la densidad de aire por el aumento de la altura tiene efectos tanto en la tensión y la corriente.

- La desclasificación de voltaje en celdas de MT por disminución de voltaje de rotura de aislamiento afectan a:
  - Voltajes nominal Vn
  - Voltaje aislamiento frecuencia industrial kV rms
  - Voltaje aislamiento descarga atmosféricas BIL kVp

- La desclasificación de la corriente nominal de la celda de MT por la disminución de la capacidad de disipación de calor afectan a los límites de elevación de temperatura de los equipos.

- Los estándares IEC 62271-200 y ANSI C37.20.2-1986 recomiendan en sus clausulas para condiciones inusuales uso de factores de corrección.

Rangos eléctricos Switchgear MT

- Los rangos eléctricos son definidos por los estándares IEC y ANSI como rangos de voltaje y niveles de aislación.

Voltaje (kV)		Voltaje Frecuencia		Voltaje decarga	
Grado Umax	Rango Un	Industrial (kV rms)		Atmosférica BIL (kVp)	
ANSI	IEC	ANSI	IEC	ANSI	IEC
	4.16		19		60
4.76		19		60	
	7.2		20		60
8.25		36		95	
	12		28		75
15		36		95	
	17.5		38		95
	24		50		125
27		60		125	
	36		80		170
38		80		150	
	40.5		95		185

Fuente: Factores de corrección de los rangos eléctricos para switchgear de media tensión aislado en aire por altitud de operación

Desclasificación por altura en Switchgear MT según IEC 62271-200

IEC 62271-200

- Corrección voltaje

$$k = \varepsilon^{\frac{m(H-1000)}{8150}}$$

Donde:

K: Factor de Corrección.

Ɛ: Exponencial (base logaritmo natural)

H: Altura en metros

M: depende de varios parametros, para diseño se considera 1.

- Corrección Corriente

$$ACF: 1 - 0.02\,\frac{(H-1000)}{100}$$

Donde:

H: Altura en metros.

imagination at work

Soluciones de distribución eléctrica MT Switchgear AIS IEC 62271-200

- IEC: http://www.gepowercontrols.com/es/product_medium_voltage/secovac.html

imagination at work

Desclasificación por altura en Switchgear MT según ANSI C37.20.2

Valores tabulados:
ANSI C37.20.2

Altura Sobre nivel del mar (metros)	Factor de Derrateo de Tensión	Factor de Derrateo de Corriente.
1000	1,00	1,00
1200	0,98	0,995
1500	0,95	0,991
1800	0,92	0,987
2000	0,91	0,985
2100	0,89	0,970
2400	0,86	0,965
2700	0,83	0,960
3000	0,80	0,950
3600	0,75	0,940
4000	0,72	0,935
4300	0,70	0,935
4900	0,65	0,925
5500	0,61	0,910
6000	0,56	0,900

imagination at work

Desclasificación por altura en Switchgear MT según ANSI C37.20.2

IEEE C37.20.2 – Ecuaciones desarrolladas por GE

Ítem	Altura (feet)	ACF
Voltaje	A<3300	ACF= 1.0
	3300≤A<5000	ACF = 1.0 – [0.0294 x (A – 3.3 Mft)]
	5000≤A<10000	ACF = 0.95 – [0.03 x (A – 5.0 Mft)]
	A≥10000	ACF= 1.0 – [0.02 x A]

Ítem	Altura (feet)	ACF
Corriente	A<3300	ACF= 1.0
	3300≤A<5000	ACF = 1.0 - 0.00588 x (A – 3.3 Mft)
	5000≤A<10000	ACF = 0.99 – 0.006 x (A – 5.0 Mft)
	A≥10000	ACF = 1.0 – 0.004 x A

imagination at work

Soluciones de distribución eléctrica MT: Switchgear AIS ANSI C37.20.2

- **NEMA**: http://www.geindustrial.com/cwc/Dispatcher?REQUEST=PRODUCTS&pnlid=5&id=powervac

POWER/VAC ®
Medium Voltage Metalclad Switchgear

imagination at work

Caso aplicativo

La Compañía Minera DEF situada a una altura de **4,500 m.s.n.m**. desea seleccionar los switchgear de media tensión para una subestación principal. El voltaje de operación es de 22,9 kV y la corriente en barras principales es de 1,500 A y una corriente de cortocircuito de 25 kA.

.

	SWITCHGEAR ANSI C37.20.2				SWITCHGEAR ANSI IEC 62271-200			
Rango	Voltaje de operación a 4,500 m.s.n.m	Factor	Nuevo rango a 4,500 m.s.n.m	Rango Switchgear (ver Tabla 2,3,4)	Voltaje de operación a 4,500 m.s.n.m	Factor Ka	Nuevo rango a 4,500 m.s.n.m	Rango Switchgear (ver Tabla 2,3,4)
Voltaje Operación	22,9 kV	0.705	31,20 kV	38 kV	22,9 kV	1.56	35.724 kV	40.5 kV
Voltaje de frecuencia industrial	50 kV	0.705	70.92 kV	80 Kv	50 kV	1.56	78kV	95 Kv
Voltaje de descarga atmosférica	125 kV	0.705	177.30 kV	150 kV	125 kV	1.56	195 kV	185 kV
Corriente Continua	2,000 A	0.94	1,880 A	2,000 A	2,000 A	0.93	1,860 A	2,000 A

imagination at work

Alternativas de solución: Uso de aparta rayos

IEEE C37.20.2 (página 40/64)

8.1.3 Application at unusual altitudes

Switchgear assemblies that depend on air for an insulating and cooling medium will have a higher temperature rise and a lower dielectric withstand capability when operated at altitudes above the values specified in item b) of Clause 4. For applications at higher altitudes, the rated maximum voltage, the rated 1 min power frequency withstand voltage, the lightning impulse withstand voltage (BIL), and continuous current rating of the assemblies should be multiplied by the correction factors in Table 8 to obtain the modified ratings. For applications above 1000 m (3300 ft), the use of surge arresters on each circuit selected to keep transient voltages below the reduced levels should be considered.

NOTE—Values given in Table 8 are currently under review by an IEEE Switchgear Committee working group. These values are given as a reference point until the revised values are available.

Para aplicaciones mayores a los 1,000 m.s.n.m. el uso de aparta rayos en cada circuito seleccionado para mantener los voltajes transitorios debajo de los niveles que debería ser considerados

Soluciones de distribución eléctrica: Switchgear MT GIS

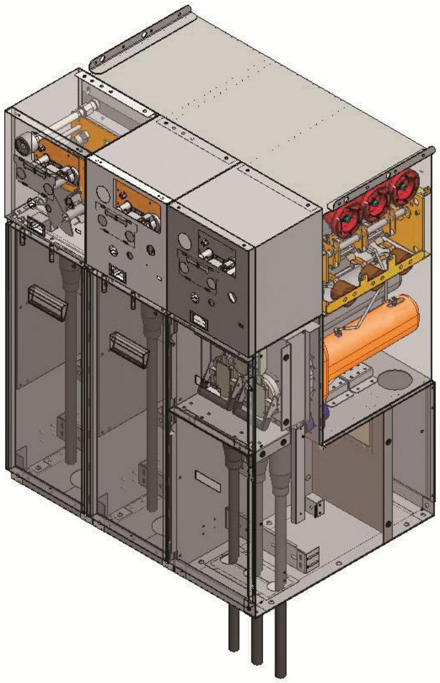
Una alternativa de solución para casos donde se tenga alturas. Se puede optar por la selección de switchgear GIS.

Características técnicas SF6:

- Aisla 2.5 veces mejor que el aire
- Mejora más de 100 veces la capacidad de enfriamiento del arco que el aire.
- Mejor disipación del calor que el aire

Ventajas:

- Fuerte resistencia a la contaminación debido a que todo la parte activa del equipo se encuentra contenido en recintos cerrados, llenos de gas SF6 a presión.
- La instalación no está sujeta a las contaminaciones ambientales tales como: ambientes corrosivos o salinos, humedad atmosférica, etc.



imagination at work

Soluciones de distribución eléctrica: Switchgear MT GIS

SecoRMU

Características técnicas:

Item		Load break switch Panel	Switch Fuse panel	Vacuum Circuit Breaker Panel
Rated Voltage:		12/17.5/24kV	12/17.5/24kV	12/17.5/24Kv
Rated Current:		630A	100A	630 A
Rated Frequency:		50 /60 Hz	50/60 Hz	50/60 Hz
Rated power Freq withstand voltage (1 min):		50kV	50kV	50kV
Rated lightening impulse withstand voltage : kVpeak		125kVp	125kVp	125kVp
Rated short-circuit making current: Ima		52kApeak	82kApeak (Prospective)	52kApeak
Rated short time withstand current: :(main circuit)		20kA – 3s	-	20kA – 3s
Rated short-circuit breaking current		-	31.5kA(Prospective)	20kA
Rated peak value withstand current:		52kAp	-	52kAp
Internal arc degree	Cable compartment IAC A FL	20kA 1s		
	Gas tank IAC A FL	20kA 1s		
IP Degree	Enclosure	IP3X		
	Gas tank	IP67		
SF6 Gas pressure at 20 ° C.-		0. 03Mpa-relative		

imagination at work

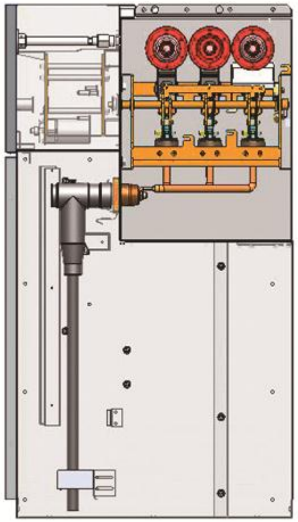
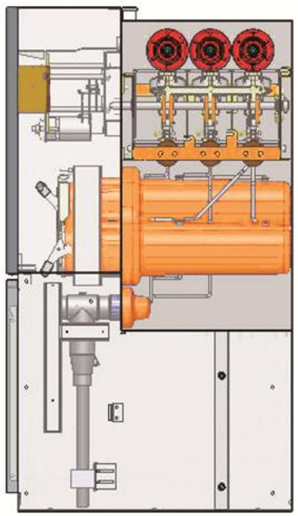
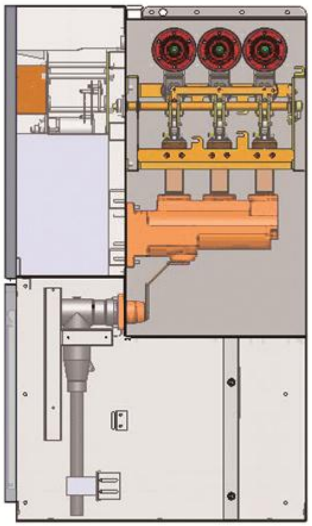
Nota: SecoRMU probado hasta una altura de 2,000 m.s.n.m.

Soluciones de distribución eléctrica: Switchgear MT GIS

SecoRMU

Celda aislada en SF6

- IEC: http://www.geindustrial-latam.com/home/productos_detail/125

K Panel	T Panel	V Panel
 Panel Seccionador	 Panel Seccionador + Fusibles	 Panel Interruptor

Comentarios

- El efecto de la altura es más notorio en el voltaje de descarga atmosférica por considerar valores que no se encuentran contemplados entre los rangos kBIL estandarizados por NEMA e IEC.

- Una selección incorrecta puede originar problemas como fallas por perdida de rigidez dieléctrica, sobre dimensionamientos de equipamiento originando sobrecostos al proyecto

- Una alternativa de solución, es seguir las recomendaciones del estándar IEEE C37.20.2 donde en su cláusula 8.1.3 recomienda el uso de pararrayos para alturas superiores de 1,000 m.s.n.m, manteniendo así, los voltajes transitorios por debajo del límite permitido.

- Otra alternativa de solución, es la posibilidad de usar switchgear aisladas en gas SF6, este tipo de equipos no se ven afectados por la altura ya que toda su parte activa se encuentra encerrada en SF6.

imagination at work

Overview

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-9V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) (0.5 KB used by bootloader)
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Schematic & Reference Design

EAGLE files: arduino-uno-reference-design.zip

Schematic: arduino-uno-schematic.pdf

Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm centre-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the analogWrite() function.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication using the SPI library.
- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- **I^2C: 4 (SDA) and 5 (SCL).** Support I^2C (TWI) communication using the Wire library.

There are a couple of other pins on the board:

- **AREF.** Reference voltage for the analog inputs. Used with analogReference().
- **Reset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the mapping between Arduino pins and ATmega328 ports?

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Uno's digital pins.

The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Programming

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno from the **Tools > Board** menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.

The ATmega8U2 firmware source code is available . The ATmega8U2 is loaded with a DFU bootloader, which can be activated by connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader). See this user-contributed tutorial for more information.

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

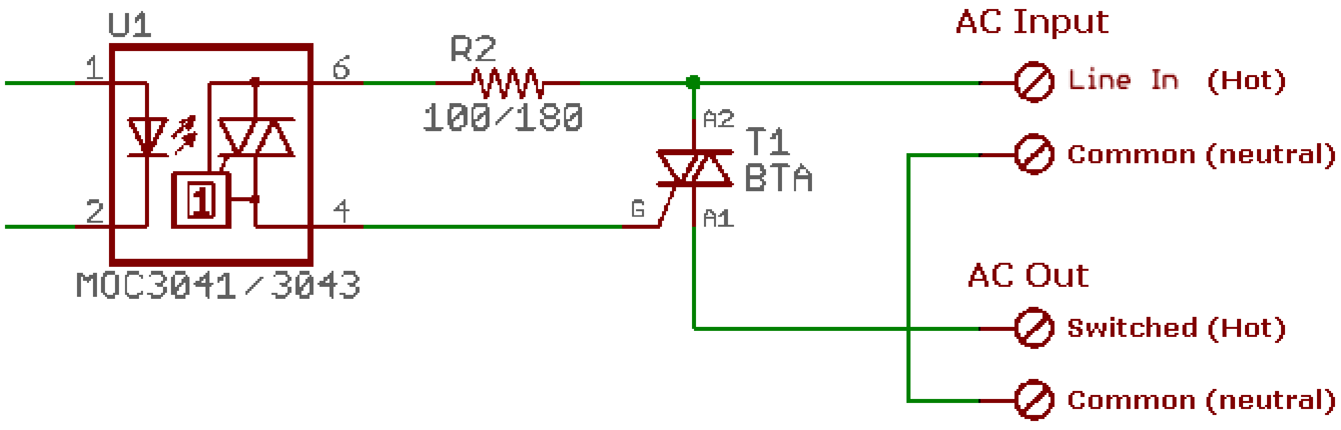
The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

This Application Note discusses the series gate resistor in the optoisolator and triac circuit. This resistor is in series with the AC line input, the high side of the opto, and the triac gate. It limits the peak current through the optoisolator. Its value is a balance between limiting peak current, and allowing enough gate current to turn on the triac. Typical values range from 100 to 180 ohms, but specific applications may require adjusting the value.

These application notes provided very helpful information:
Littlefuse/Teccor AN1002 Gating, Latching, and Holding of SCRs and Triacs
Littlefuse/Teccor AN1007 Teccor Thyristors Used as AC Static Switches and Relays
Fairchild Semi AN-3003 Applications of Non Zero Crossing Triac Drivers Featuring the MOC3011

These and the other app notes on these sites provide a lot of detail.

This is meant to be a general discussion, but assumes some basic electrical knowledge. We assume no liability for any content here, or what you do with it; experiment at your own risk, and with low voltages. Please let me know if you have any corrections or suggestions (including the math :)



Series Gate Resistor

This note shows simplified portions of the SimpleIO TriacOut4 and TriacOut8 boards. The schematic above shows an optoisolator U1, the series gate resistor R2, and a triac T1. The triac terminals are labeled G for the gate, and A1 and A2 for the AC terminals. These labels come from the datasheet; many application notes label these G, MT1, and MT2. The connectors on the right are for line input and the switched output for the load. This omits the line fuse for simplicity.

The SimpleIO boards have the following values:

TriacOut4: MOC3041, 100 ohm resistor, BTA08-400B 50 mA gate Triac.
TriacOut8: MOC3043, 180 ohm resistor, BTA08-400B 50 mA gate Triac.

The change in the resistor from 100 to 180 ohms are the from evolution of the design, and the subject of this note. The opto difference from 3041 to 3043 is discussed elsewhere, in the DC Logic Input note (TODO).

Resistor value

The value of the series gate resistor is a balancing act between limiting the peak current through the opto, and allowing enough gate current to turn on the triac.

From the Fairchild Application Note AN-3003:
The max surge current rating of the optoisolator, I_{TSM}, is 1 A for the MOC series of optos.
The peak voltage for a 120 VAC line is 120 x 1.414 = 170 V, so R = 170 V / 1 A = 170 ohms minimum.
Round up to **180 ohms** for a standard value.

The balance comes in here for the gate current and the line voltage to drive it. The minimum voltage needed to turn on the triac is determined by adding up the gate current through the resistor I_{GT}, the triac gate voltage V_{GT}, and the opto on-state output voltage V_{TM}.
$R \times I_{GT} + V_{GT} + V_{TM}$ = 180 ohms x 50 mA + 1.3 V + 3 V = 13 V.

The Littlefuse/Teccor Application Note AN1007 suggests dropping it to 100 ohms with a different opto:

"A common mistake in this circuit is to make the series gate resistor too large in value. A value of 180 ohms is shown in a typical application circuit by optocoupler manufacturers. The 180 ohms is based on limiting the current to 1 A peak at the peak of a 120 V line input for Fairchild and Toshiba optocoupler I_{TSM} rating. This is good for protection of the optocoupler output triac, as well as the gate of the power triac on a 120 V line; however, it must be lowered if a 24 V line is being controlled, or if the RL (resistive load) is 200 W or less. This resistor limits current for worst case turnon at the peak line voltage, but it also sets turn-on point (conduction angle) in the sine wave, since triac gate current is determined by this resistor and produced from the sine wave voltage. The load resistance is also important, since it can also limit the amount of available triac gate current. A 100 ohms gate resistor would be a better choice in most 120 V applications with loads greater than 200 W and optocouplers from Quality Technologies or Vishay with optocoupler output triacs that can handle 1.7 A_{PK} (I_{TSM} rating) for a few microseconds at the peak of the line. For loads less than 200 W, the resistor can be dropped to 22 ohms. Remember that if the gate resistor is too large in value, the triac will not turn on at all or not turn on fully, which can cause excessive power dissipation in the gate resistor, causing it to burn out."

On the SimpleIO boards, we went from 100 ohms to 180 ohms, just to follow the peak current limit more precisely.

The TriacOut4 board has 100 ohms from the original design. This is good for lower input voltages and turning on the triac. It is a little low for the peak current on the opto, but has been ok as a practical matter.

The TriacOut8 board has 180 ohms to help with the peak current. This may be too high for 24 Vac inputs, but the option above to use other optos was too expensive.

The resistor values can be changed to suit specific applications.

Line input voltage

The above discussion notes the input voltage also affects the resistor value. For **115 Vac**, **100** or

180 ohms will work fine for most loads. The 180 is a little too high for a 24 Vac line to trigger the gate, and too low for a 220 Vac line for the opto peak current limit.

For **24 Vac** line, the triac will turn on with the 100 ohm and 180 ohm resistors, but I think the initial turn-on cycle will be 'late', at 13 V max (but I think it stays on once turned on). A resistor value better suited is:
24 x 1.414 = 34 V, so R = 34 V / 1 A = 34 ohms minimum. Round to **33 ohms** for a standard value.
The max triac turn-on voltage will be:
R x I_{GT} + V_{GT} + V_{TM} = 33 ohms x 50 mA + 1.3 V + 3 V = 6.0 V.

For **220 Vac** line (use 230 to be consistent with the 115 math):
230 x 1.414 = 325 V, so R = 325 V / 1 A = 325 ohms minimum. Round to **360 ohms** for a standard value.
The max triac turn-on voltage will be:
R x I_{GT} + V_{GT} + V_{TM} = 360 ohms x 50 mA + 1.3 V + 3 V = 22 V.

Resistor wattage

The resistor has a 1/4 W power rating, determined by measuring a typical board for timing, then applying the max current spec. The average power is very small.

Measuring the voltage across the resistor when the triac is on showed a 5 mA pulse for about 50 us every half cycle of AC. Apparently, this is when the triac is switching, and draws current on the gate.

To calculate the Root-Mean-Square (RMS) power through the resistor, let's use the 50 us as the pulse time, but increase the current to the 50 mA max spec'ed for the triac.

The square of the max current is $(50\ mA)^2 = 2500\ uA^2$.
The mean (average) over the time is 50 us / 16.6 ms for the AC half cycle.
So the average squared current is 2500 x 50 us / 16.6 ms = 7.5.
Take the square root to get 2.7 mA as the RMS current.

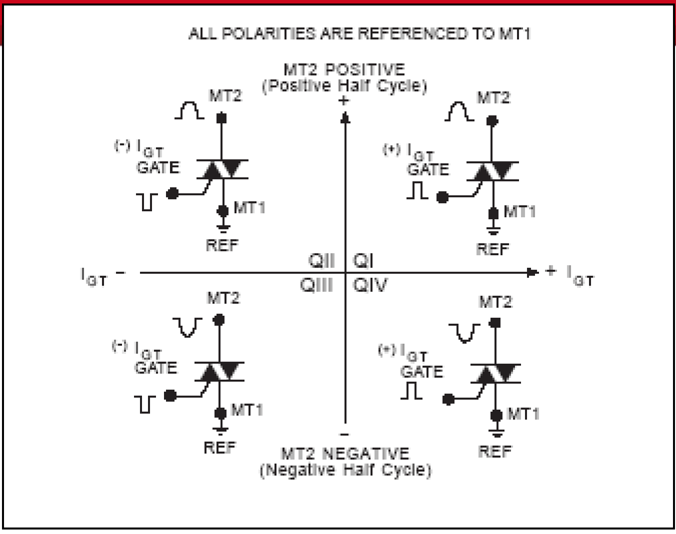
The RMS power is then simply I^2 x R = $(2.7\ mA)^2$ x 100 ohms = 1.5 mW.
For the 180 ohm resistor, the RMS power is $(2.7\ mA)^2$ x 180 ohms = 2.7 mW.
These are both well under 1/4 W.

The SimpleIO boards use a miniature resistor from Panasonic, to keep the physical size small to help with clearances from the high voltage traces. This drove the goal of determining that the 1/4 W rating was ok.

Quadrants

Just a side note on operating quadrants.
The max gate current spec, I_{GT}, is 50 mA in quadrant I, II, and III; and 100 mA in quadrant IV.

With A1 as the reference, Quadrant I is where the gate is positive when A2 is positive. Quadrant III is where the gate is negative when A2 is negative. Since this circuit has the hot coming into A2 and around to the gate, the gate always matches A2, so it always operates in quadrants I and III. So, we used the 50 mA spec above.



Operating Quadrants in Triacs
Figure from Littlefuse Teccor Application Note AN1002
Gating, Latching, and Holding of SCRs and Triacs

Author: Bob Cooley

```
/////////////////////////////////////////////////////////////////////////////////////////////////
/// CODIGO DE PROGRAMACION TESIS    //////////////////////////////////////////////////////////
//  ELABORADO POR: RENZO LOPEZ DE PAZ ////////////////////////////////////////////////////////
//  AÑO: 2016   //////////////////////////////////////////////////////////////////////////////
/////////////////////////////////////////////////////////////////////////////////////////////////


const int analogInPin = A1;   //Entrada analógica del potenciómetro;/////////////////////////////

float sensorValue;            //Valor leído del Potenciómetro;/////////////////////////////////////

int AC_pinV = 6;                //Pin6  al MOC3020 – OptoTriac Ventilador;////////////////////////

int AC_pinF = 5;                //Pin5  al MOC3020 – OptoTriac Foco;/////////////////////////////

boolean FlagInterrupt = LOW;

float Ang;

/////////////////////////////////////////////////////////////////////////////////////////////////
float Temp;

float AngV;

float AngF;

float voltaje;

/////////////////////////////////////////////////////////////////////////////////////////////////
float Angmin=100;

float Angmax=8000;

float Tsp=20;

float Tmax=30;

float Tmin=0;

/////////////////////////////////////////////////////////////////////////////////////////////////

void setup()

{

Serial.begin(9600);

/////////////////////////////////////////////////////////////////////////////////////////////////

pinMode(2, INPUT_PULLUP);    //////////////// entrada en pull-up para la interrupción./////////

/////////////////////////////////////////////////////////////////////////////////////////////////
attachInterrupt(0,ZeroDetect,RISING);//Llamada de  Interrupción cuando se detecta en el
cambio de nivel bajo a alto. //////////////////////////////////////////////////////////////////
```

```
}
void loop()
{
  sensorValue = analogRead(analogInPin);  ////////Lectura del sensor(pin Analógico);///////////
  voltaje=(sensorValue*5)/1024;
  Temp= (((Tmax-Tmin)*voltaje)/5)+Tmin;
  Serial.print(Temp);     //Envío de variable de Temperatura por serial (Visualizada en LabView);
  delay(200);

  if(FlagInterrupt==HIGH)
   {
      FlagInterrupt=LOW;
      if (Temp <= Tmin) {                    /////////////FOCO MAXIMA POTENCIA/////////////////
      digitalWrite(AC_pinF, HIGH);
      }
      if (Temp >= Tmax) {                   /////////////VENTILADOR MAXIMA POTENCIA//////////
      digitalWrite(AC_pinV, HIGH);
      }
/////////////////////////////////////////////////////////////////////////////////////////////////
////////////////FOCO ENCENDIDO///////////////////////////////////////////////////////////////////
/////////////////////////////////////////////////////////////////////////////////////////////////

      if (Temp < Tsp)
   {
      digitalWrite(AC_pinV, LOW);
      AngV=(((Angmax-Angmin)*(Temp-Tsp))/(Tsp-Tmax))+Angmax;
      delayMicroseconds(AngV);
      digitalWrite(AC_pinF, HIGH);
      delayMicroseconds(500);
      digitalWrite(AC_pinF, LOW);
```

```
      }
////////////////////////////////////////////////////////////////////////////////////////////////////
///////////VENTILADOR ENCENDIDO///////////////////////////////////////////////////////////////
////////////////////////////////////////////////////////////////////////////////////////////////////
      if (Temp >= Tsp)
 {                                      digitalWrite(AC_pinF, LOW);
       AngF=(((Angmax-Angmin)*(Temp))/(Tsp))+Angmin;
       delayMicroseconds(AngF);
       digitalWrite(AC_pinV, HIGH);
       delayMicroseconds(500);
       digitalWrite(AC_pinV, LOW);
      }
////////////////////////////////////////////////////////////////////////////////////////////////////
////////////////////////////////////////////////////////////////////////////////////////////////////
  }
}
void ZeroDetect()
{
   FlagInterrupt= HIGH;
}
////////////////////////////////////////////////////////////////////////////////////////////////////
///////////////////////////////////////////////////////////////////////////////////////////////////
```

DATOS ESTADÍSTICOS EN LA PROVINCIA DE BOLOGNESI

INDICADORES	ELECTRIFICACION	TELECOMUNI-CACIONES	PRODUCCION	MEDIO AMBIENTE	SOCIO - CULTURAL	INSTITUCIONAL
LA PRIMAVERA	Deficiente servicio de energía eléctrica (existen altas y bajas en la tensión) Inexistencia de electricidad trifásica	Ineficiente servicio de telecomunicación, Inexistencia de cabinas de internet. Solo existe telefonía móvil. (movistar)	Falta asistencia técnica en la producción agrícola y pecuaria Falta de agua no permite la ampliación de la frontera agrícola, existiendo grandes áreas para la agricultura	Deforestación en la zona Existencia de una falla geológica en medio de la ciudad	Nula presencia de los programas sociales del Gobierno. Violencia familiar Alta migración de la población joven	Falta de programas de fortalecimiento institucional, lo que hace la desgobernabilidad Poca participación ciudadana por falta de organizaciones consolidadas
MANGAS	02 anexos no cuenta con luz	Ineficiente servicio de telecomunicación, solo existe 01 teléfono rural y cobertura de telefonía móvil (movistar) Inexistencia de cabinas de internet	Agricultura y ganadería de subsistencia Falta asistencia técnica en la producción agrícola y pecuaria Falta asesoramiento y capacitación para la producción de lácteos	Alto índice de contaminación por falta de rellenos sanitarios Deforestación	Nula presencia de los programas sociales del Gobierno. Violencia familiar Alta migración de la población joven.	Falta de programas de fortalecimiento institucional. Inexistencia de un plan de capacitación a la junta de regantes, comité de agua Inexistencia de un plan de ordenamiento territorial
ABELARDO PARDO LEZAMETA	Deficiente servicio, eléctrico, (cortes inesperados y constantes).	Ineficiente servicio de telecomunicación, solo existe 01 teléfono rural y cobertura de telefonía móvil (movistar) Inexistencia de cabinas de internet	Falta asistencia técnica en la producción agrícola y pecuaria Presencia de plagas y enfermedades. Falta conocimientos por productos orgánicos	Alto índice de contaminación por falta de rellenos sanitarios y tratamiento de residuos sólidos	Alto nivel de alcoholismo en la juventud , y menores de edad	Falta de programas de fortalecimiento institucional.
CANIS	Deficiente alumbrado publico en la capital Inexistencia de servicio eléctrico en 02 anexos	Deficiente cobertura telefónica y de servicio de internet. Cobertura de telefonía móvil (movistar)	Agricultura y ganadería de subsistencia Falta asistencia técnica en la producción agrícola y pecuaria	Alto índice de contaminación por falta de rellenos sanitarios Deforestación	Violencia familiar Alto nivel de alcoholismo Alta migración de la población Desocupación	Falta de programas de fortalecimiento institucional. Deficiente participación y concertación de las autoridades y sociedad civil
TICLLOS	Deficiente servicio eléctrico Deficiente alumbrado público	Deficiente servicio de telefonía móvil Inexistencia de servicio de internet.	Agricultura y ganadería de subsistencia Falta asistencia técnica en la producción agrícola y pecuaria	Deforestación Existencia de movimiento de tierras en Roca No hay relleno sanitario Las 02 lagunas contaminadas	Alto nivel alcoholismo Violencia familiar Delincuencia juvenil, pandillaje, en la comunidad de Roca Alto porcentaje de Madres Jóvenes	Falta de programas de fortalecimiento institucional. Deficiente participación y concertación de las autoridades y sociedad civil Inexistencia de comité de defensa civil
COLQUIOC	Deficiente servicio de energía eléctrica. Deficiente servicio de alumbrado público en el área rural	Deficiente cobertura telefónica y de servicio de internet. Inexistencia de servicio de telefonía móvil.	Inexistencia de un centro de acopio Falta capacitación y asistencia técnica a fruticultores Deficiente sistema de riego que limita la producción	Contaminación del río Fortaleza Ausencia de un programa de reforestación en las partes altas, que exponen a la población a deslizamientos, huaycos y aluviones Falta defensas ribereñas	Perdida de identidad y cultura Violencia familiar Alto nivel de alcoholismo	La municipalidad no tiene DEMUNA Falta de programas de fortalecimiento institucional. Carencia de licencia de funcionamiento en negocios locales
HUAYLLAYCAYAN	Carencia de energía eléctrica en 02 anexos	Inexistencia de servicio de telefonía fija y móvil Inexistencia de servicio de internet	Presencia de plaga de la frutas (mosca de la fruta) Ausencia de programas de SENASA Falta de pastos forrajeros para la ganadería Agricultura y ganadería de subsistencia Falta asistencia técnica en la producción agrícola y pecuaria Falta asesoramiento y capacitación para la producción de lácteos	Inexistencia de un programa de adecuación y de manejo medio ambiental Las lagunas existentes en la zona se vienen secando, lo que ha llevado a la escasez y reducción del agua para los diferentes usos.	Violencia familiar Alto nivel de alcoholismo	Falta de programas de fortalecimiento institucional, y de desarrollo de capacidades locales

heliplast
CHRISTOF HORN Y CIA LTDA

ISO 9001:2008

31 años
Estuvimos de aniversario 18 de Julio

Energía Solar Fotovoltaica, Energía Eólica e Hidráulica.

Somos Representantes, Distribuidores directos de fabrica de las marcas más prestigiosas del rubro energías renovables; SOLARWORLD AG, HYUNDAI, KOMAES SOLAR, INGETEAM, ABB, ENPHASE, SMA, STECA, SCHNEIDER ELECTRIC SOLAR, SHURFLO, VICTRON ENERGY, LINGENHOELE PRIMUS WIND POWER, ABLAMP, DEKA SOLAR, NEWMAX, .

Heliplast desde 1984, 31 años de experiencia.

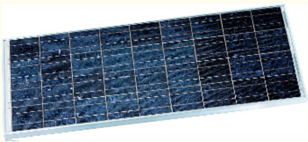
Nota: Valores sujetos a cambio sin previo aviso.

CHRISTOF HORN Y CIA LTDA, Luis Thayer Ojeda 0180 of 904, Providencia - Santiago Chile
Fono Fax: (56-2) 23340800 – 23346904, E-mail: christof.horn@heliplast.cl, Web:www.heliplast.cl

CEEZ

MODULOS FOTOVOLTAICOS CON CERTIFICACION IEC 61215 y 61730

25 años de garantía por la potencia mínima garantizada



CODIGO	DESCRIPCION							VALOR S/IVA	CON 19% IVA
15152444K	MODULO **KOMAES**	**KM10P**	**Poly**	10Wp	12V	0.66	Acc	$ 18.000.-	$ 21.420.-
15155366K	MODULO **KOMAES**	**KM20P**	**Poly**	20Wp	12V	1.23	Acc	$ 29.000.-	$ 34.510.-
15155350K	MODULO **KOMAES**	**KM50P**	**Poly**	50Wp	12V	3.04	Acc	$ 45.000.-	$ 53.550.-
15155085K	MODULO **KOMAES**	**KM85P**	**Poly**	85Wp	12V	5.10	Acc	$ 76.000.-	$ 90.440.-
15155300K	MODULO **KOMAES**	**KM100P**	**Poly**	100Wp	12V	6.09	Acc	$ 86.000.-	$ 102.340.-
15155130K	MODULO **KOMAES**	**KM130P**	**Poly**	130Wp	12V	7.65	Acc	$ 107.000.-	$ 127.330.-
15155250M	MODULO **KOMAES**	**KM250M**	**Poly**	250Wp	36V	8.5	Acc	$ 206.000.-	$ 245.140.-
15152350P	MODULO **SOLARWORLD**	**SW50P**	**Poly**	50Wp	12V	2.95	Acc	$ 62.000.-	$ 73.780.-
*151524852	MODULO **SOLARWORLD**	**SW85RNA**	**Poly**	85Wp	12 V	5.20	Acc	$ 104.000.-	$ 123.760.-
15152140P	MODULO **SOLARWORLD**	**SW145P**	**Poli**	145Wp	12 V	8.69	Acc	$ 177.000.-	$ 210.630.-
15152750M	MOD **SOLARWORLD**	**SW275 frame 2.0**	Mono	275 Watt	39,4V	8.99	Acc	$ 300.000.-	$ 357.000.-
15152280M	MOD **SOLARWORLD**	**SW280 frame 33mm**	Mono	280 Watt	39,5V	9,71	A	$ 306.000.-	$ 364.140.-
*15152345M	**SOLARWORLD**	**SW345 XL frame 33mm**	Mono	345 Watt	47,8V	9,75	A	consulte solo por contenedor 40”	

Próximamente, Módulos PV marca Hyundai a partir de Enero 2016

*19156250H	MODULO **HYUNDAI**	**HiS-M250RG**	**Poly**	250Wp	37,4V	8,7	Acc	$ 207.000.-	$ 246.330.-
*19156255H	MODULO **HYUNDAI**	**HiS-M255RG**	**Poly**	255Wp	37,6V	8,8	Acc	$ 215.000.-	$ 255.850.-
*19156260H	MODULO **HYUNDAI**	**HiS-M260RG**	**Poly**	260Wp	37,7V	8,9	Acc	$ 223.000.-	$ 265.370.-

Todos los módulos fotovoltaicos SOLARWORLD y KOMAES SOLAR tienen certificación IEC 61215 y IEC61730 y están certificados por el SEC bajo la norma de la ley 20.571 Net Metering.

*** No hay disponibilidad a la fecha, o la cantidad es limitada, consulte por existencia al Fono: (2) 23340800 / (2) 23346904** o al e-mail christof.horn@heliplast.cl

www.heliplast.cl

CEEZ

INVERSORES ON GRID, GRID TIE PARA CONEXIÓN A LA RED PUBLICA:

ABB POWER ONE, INGETEAM, SMA, STECA, SCHNEIDER ELECTRIC, MICRO INVERSORES ENPHASE.

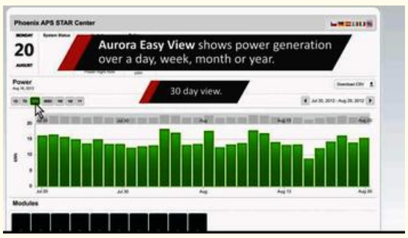
Nota: Todos los Inversores ON GRID no aplican Descuento, son precios para Distribuidores.

Nota: Todos los Inversores ON GRID no aplican Descuento

CODIGO	DESCRIPCIÓN	VALOR S/IVA	VALOR 19% IVA
INVERSORES ON GRID SERIE MICRO INVERTERS ENPHASE USA MONOFASICOS 230 Volt 50Hz			
1716215	MICRO INVERSOR **ENPHASE M215** 215W 230 Volt AC 50 Hz	$ 178.000.-	$ 211.820.-
1716250	MICRO INVERSOR **ENPHASE M250** 250W 230 Volt AC 50 Hz	$ 196.000.-	$ 233.240.-
1716001	Cable AC y conector para cada Micro inversor Enphase	$ 48.000.-	$ 57.120.-
1716301	Envoy sistema de Monitoreo remoto para inversores Enphase	$ 525.000.-	$ 624.750.-
INVERSORES ON GRID ABB SERIE UNO MONOFASICO 230 Volt 50Hz			
17162000	INVERSOR **ABB** UNO 2,0 OUTD-S 2.000 W 230 Volt 50Hz	$ 903.000.-	$ 1.074.570.-
17162500	INVERSOR **ABB** UNO 2,5 OUTD-S 2.500 W 230 Volt 50Hz	$ 982.000.-	$ 1.168.580.-
INVERSORES ON GRID ABB SERIE TRIO MONOFASICO 230 Volt 50Hz / SIN TRANSFORMADOR			
17163000	INVERSOR **ABB** PVI 3 OUTD-TL-S 3000 W 230 Volt 50Hz	$ 960.000.-	$ 1.142.400.-
17163600	INVERSOR **ABB** PVI 3,6 OUTD-TL-S 3600 W 230 Volt 50Hz	$ 1.075.000.-	$ 1.279.250.-
17164200	INVERSOR **ABB** PVI 4,2 OUTD-TL-S 4200 W 230 Volt 50Hz	$ 1.164.000.-	$ 1.385.160.-
17165000	INVERSOR **ABB** PVI 5,0 OUTD-TL-S 5000 W 230 Volt 50Hz	$ 1.295.000.-	$ 1.541.050.-
INVERSORES ON GRID ABB SERIE TRIO TRIFASICO 400 Volt 50Hz / SIN TRANSFORMADOR			
17166000	INVERSOR **ABB** PVI 6,0 OUTD-TL-S 6000 W 400 Volt 50Hz	$ 1.445.000.-	$ 1.719.550.-
17110000	INVERSOR **ABB** PVI 10.0 OUTD-TL-FS 10.000 W 400 Volt 50Hz	$ 2.095.000.-	$ 2.493.050.-
17112500	INVERSOR **ABB** PVI 12.5 OUTD-TL-FS 12.500 W 400 Volt 50Hz	$ 2.334.000.-	$ 2.777.460.-
INVERSORES ON GRID ABB SERIE TRIO TRIFASICO 400 Volt 50Hz / SIN TRANSFORMADOR			
17120000	INVERSOR **ABB** TRIO 20.0 OUTD-TL-S2 20.000 W 400 Volt 50Hz	$ 3.416.000.-	$ 4.065.040.-
17127600	INVERSOR **ABB** TRIO 27.6 OUTD-TL-S2 27.600 W 400 Volt 50Hz	$ 3.935.000.-	$ 4.682.650.-

SISTEMAS DE COMUNICACIÓN Y MONITOREO ABB

1716111	AURORA LOGGER MAX VSN-MGR-MAX
1716112	AURORA VISION
1716113	AURORA EASY VIEW
1716114	AURORA WEATHER STATION VSN-ENVIRO-CMML



Nota: Todos los Inversores ON GRID de ABB, Schneider Electric, Ingeteam, Enphase, SMA y STECA no aplican Descuento
Inversores ON GRID, valores son solo para distribuidores autorizados por Heliplast Ltda

INVERSORES ON GRID, GRID TIE PARA CONEXIÓN A LA RED PUBLICA SMA.

1515306	INVERSOR **SMA** SB1200 de 1200 Watt 230 Volt 50 Hz	$ 705.000.-	$ 838.950.-
1518160	INVERSOR **SMA** SB1500TL de 1500 Watt 230 Volt 50 Hz	$ 630.000.-	$ 749.700.-
1518162	INVERSOR **SMA** SB2500TL de 2500 Watt 230 Volt 50 Hz	$ 755.000.-	$ 898.450.-
15053TL	INVERSOR **SMA** SB3000TL de 3000 Watt 230 Volt 50 Hz	$ 1.247.000.-	$ 1.483.930.-
1518165	INVERSOR **SMA** SB4000TL de 4000 Watt 230 Volt 50 Hz	$ 1.325.000.-	$ 1.576.750.-
15055TL	INVERSOR **SMA** SB5000TL de 5000 Watt 230 Volt 50 Hz	$ 1.515.000.-	$ 1.802.850.-
15155TL	INVERSOR **SMA**TRIFASICO SUNNY TRIPOWER 5.000TL	$ 1.820.000.-	$ 2.165.800.-
1518166	INVERSOR **SMA**TRIFASICO SUNNY TRIPOWER 6000TL	$ 2.025.000.-	$ 2.409.750.-
15178TL	INVERSOR **SMA**TRIFASICO SUNNY TRIPOWER 8.000TL	$ 2.335.000.-	$ 2.778.650.-
15110TL	INVERSOR **SMA**TRIFASICO SUNNY TRIPOWER 10.000TL	$ 2.678.000.-	$ 3.186.820.-
15115TL	INVERSOR **SMA**TRIFASICO SUNNY TRIPOWER 15.000TL	$ 3.603.000.-	$ 4.287.570.-
15120TL	INVERSOR **SMA**TRIFASICO SUNNY TRIPOWER 20.000TL	$ 3.318.000.-	$ 3.948.420.-
1515001	Sistema monitoreo remoto **SMA** Web Box Bluetooth, 1GB	$ 515.000.-	$ 612.850.-
1515001	Inversores **SUNNY CENTRAL** 500MV-20 / 630MV-20 / 800MV-20 / 1000MV-	$ consultar valores	

INVERSORES ON GRID, GRID TIE PARA CONEXIÓN A LA RED PUBLICA. Schneider Electric Solar.

19183000	INVERSOR	RL 3000 E	3 kW 3000 W	230 Volt AC 50 Hz	$ 895.000.-	$ 1.065.050.-
19184000	INVERSOR	RL 4000 E	4 kW 4000 W	230 Volt AC 50 Hz	$ 1.056.000.-	$ 1.256.640.-
19185000	INVERSOR	RL 5000 E	5 KW 5000 W	230 Volt AC 50 Hz	$ 1.145.000.-	$ 1.362.550.-
19183000	INVERSOR	CL20000 E	20 kW 20.000 W	400Volt AC 50 Hz	$ 3.480.000-	$ 4.141.200.-
19184000	INVERSOR	CL25000 E	25 kW 25.000 W	400 Volt AC50 Hz	$ 3.554.000.-	$ 4.229.260.-

INVERSORES ON GRID, GRID TIE PARA CONEXIÓN A LA RED PUBLICA: STECA.

1515301	INVERSOR **Steca Grid**	132 VCC	300 W	230 Volt AC 50Hz	$ 250.000.-	$ 297.500.-
1515360	INVERSOR **Steca Grid**	400 VCC	3600 W	230 Volt AC 50Hz	$ 1.185.000.-	$ 1.410.150.-

INVERSORES ON GRID, GRID TIE PARA CONEXIÓN A LA RED PUBLICA. INGETEAM.

Modelos: Ingecon sun 1 Play MULTI- MPPT MONOFASICO

2012500	Inversor On grid Monofásico 2,5 kW TL M (DC SW) 220 Volt 50Hz	$ 803.000.-	$ 955.570.-
2013000	Inversor On grid Monofásico 3.0 kW TL M (DC SW) 220 Volt 50Hz	$ 818.000.-	$ 973.420.-
2015000	Inversor On grid Monofásico 5.0 kW TL M (DC SW) 220 Volt 50Hz	$ 1.048.000.-	$ 1.247.120.-
2016000	Inversor On grid Monofásico 6.0 kW TL M (DC SW) 220 Volt 50Hz	$ 1.204.000.-	$ 1.432.760.-

Modelo Ingecon sun 3 Play MULTI-MPPT TRIFASICO

20110000	Inversor On grid Trifásico 10.0 kW TL M (S+) 380 Volt 50Hz	$ 2.284.000.-	$ 2.717.960.-
20112500	Inversor On grid Trifásico 12,5 kW TL M (S+) 380 Volt 50Hz	$ 2.340.000.-	$ 2.784.600.-
20115000	Inversor On grid Trifásico 15.0 kW TL M (S+) 380 Volt 50Hz	$ 2.250.000.-	$ 2.677.500.-
20120000	Inversor On grid Trifásico 20.0 kW TL M (S+) 380 Volt 50Hz	$ 2.876.000.-	$ 3.422.440.-

Los inversores de Ingeteam están programados y calibrados de fabrica para opción País Chile.
Sistemas para monitoreo remoto favor consultar

Nota: Todos los Inversores ON GRID de ABB, Schneider Electric, INGETEAM, Enphase, SMA y STECA no aplican Descuento
Inversores ON GRID, valores son solo para distribuidores autorizados por Heliplast Ltda

ESTRUCTURAS DE SOPORTE PARA MÓDULOS FOTOVOLTAICOS

CODIGO	DESCRIPCION	VALOR S/IVA	CON 19% IVA
15152361	**SGM8** PARA 5 UNID SW85/75 o 4 SW130/140	$ 305.000.-	$ 362.950 .-

REGULADORES DE CARGA, PMW

Display digital, programables, función nocturna, Monitoreo remoto

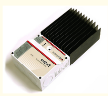




15152406	REGULADOR de carga **SOLSUM** 8.8F	12/24 Volt 8 AMP	$ 22.000.-	$ 26.180.-
15152437	REGULADOR de carga **PRS1010**	12/24 Volt 10 AMP	$ 45.000.-	$ 53.550.-
15152415	REGULADOR de carga **PRS1515**	12/24 Volt 15 AMP	$ 48.000.-	$ 57.120.-
15152425	REGULADOR de carga **PRS2020**	12/24 Volt 20 AMP	$ 54.000.-	$ 64.260.-
15152432	REGULADOR de carga **PRS3030**	12/24 Volt 30 AMP	$ 70.000.-	$ 83.300.-
15152415B	REGULADOR de carga + **LCD PR1515**	12/24 Volt 15 AMP	$ 80.000.-	$ 95.200.-
15152435	REGULADOR de carga + **LCD PR3030**	12/24 Volt 30 AMP	$ 112.000.-	$ 133.280.-
15152379N	New REGULADOR **TAROM 4545**	12/24 Volt 45 AMP	$ 230.000.-	$ 273.700.-
15152380N	New REGULADOR **TAROM 4545 - 48**	12/24/48 Volt 45 AMP	$ 256.000.-	$ 304.640.-
15152070	REGULADOR **POWER TAR0M 2070**	12/24 V 70 Amp	$ 945.000.-	$ 1.124.550.-
15152140	REGULADOR **POWER TAR0M 2140**	12/24 V 140 Amp	$ 1.222.000.-	$ 1.454.180.-
15154055	REGULADOR **POWER TAR0M 4055**	48 V 55 Amp	$ 1.078.000.-	$ 1.282.820.-
15154110	REGULADOR **POWER TAR0M 4110**	48 V 110 Amp	$ 1.378.000.-	$ 1.639.820.-
15154140	REGULADOR **POWER TAR0M 4140**	48 V 140 Amp	$ 1.579.000.-	$ 1.879.010.-
15154148	REGULADOR **Morningstar** Prostar PS-30	12/24 V 30 Amp	$ 135.000.-	$ 160.650.-

REGULADORES DE CARGA MPPT






15152475	**REGULADOR STECA MPPT 2010** 100V -12/24 Volt 20 AMP	$ 188.000.-	$ 223.720.-
15151370	**REGULADOR STECA TAROM MPPT 6000** 200V -12/2/48 Volt 60A	$ 725.000.-	$ 862.750.-
15157150	**MORNINGSTAR TRISTAR** TS MPPT 45 45A 150V P/ 12/24/36/48 V	$ 472.000.-	$ 561.680.-
15157160	**MORNINSGTAR TRISTAR** TS MPPT 60 60A 150V P/ 12/24/36/48 V	$ 595.000.-	$ 708.050.-
15157100	**MORNINGSTAR TRISTAR METER DISPLAY Digital para** TS MPPT	$ 98.000.-	$ 116.620.-
15153071	**REGULADOR Victron Blue solar MPPT** 75/15 75V 12/24-15 A	$ 88.000.-	$ 104.720.-
15153015	**REGULADOR Victron Blue solar MPPT** 100/15 75V 12/24-15 A	$ 108.000.-	$ 128.520.-
15153050	**REGULADOR Victron Blue solar MPPT** 100/50 /12/24V 50 A	$ 293.000-	$ 348.670.-
15153070	**REGULADOR Victron Blue solar MPPT** 150/70 12/24/36/48V 70 A	$ 634.000.-	$ 754.460.-
15153085	**REGULADOR Victron Blue solar MPPT** 150/85 12/24/36/48V 85 A	$ 712.000.-	$ 847.280.-

Nota: Valores sujetos a cambio sin previo aviso.

INVERSORES OFF GRID DE ONDA SINUSOIDAL PURA

CODIGO	DESCRIPCION	VALOR S/IVA	CON 19% IVA
15152411	INVERSOR **PHOENIX** SINUS 12 V 180W 220 Volt 50 Hz	$ 104.000.-	$ 123.760.-
15152412	INVERSOR **PHOENIX** SINUS 24 V 180W 220 Volt 50 Hz	$ 104.000.-	$ 123.760.-
15151702	INVERSOR **PHOENIX** SINUS 12 V 350W 220 Volt 50 Hz	$ 135.000.-	$ 160.650.-
15151703	INVERSOR **PHOENIX** SINUS 24 V 350W 220 Volt 50 Hz	$ 135.000.-	$ 160.650.-
15151704	INVERSOR **PHOENIX** SINUS 48 V 350W 220 Volt 50 Hz	$ 151.000.-	$ 179.690.-
15152399	INVERSOR **PHOENIX** SINUS 12 V 800W 220 Volt 50 Hz	$ 338.000.-	$ 402.220.-
15152750	INVERSOR **PHOENIX** SINUS 24 V 800W 220 Volt 50 Hz	$ 338.000.-	$ 402.220.-
15152380	INVERSOR **PHOENIX** SINUS 48 V 800W 220 Volt 50 Hz	$ 342.000.-	$ 406.980.-
15301200	INVERSOR **PHOENIX** SINUS 12 V 1200W 220 Volt 50 Hz	$ 617.000.-	$ 734.230.-
15152327	INVERSOR **PHOENIX** SINUS 48 V 1200W 220 Volt 50 Hz	$ 528.000.-	$ 628.320.-
15151600	INVERSOR **PHOENIX** SINUS 12 V 1600W 220 Volt 50 Hz	$ 754.000.-	$ 897.260.-
15241600	INVERSOR **PHOENIX** SINUS 24 V 1600W 220 Volt 50 Hz	$ 754.000.-	$ 897.260.-
15123000	INVERSOR **PHOENIX** SINUS 12 V 3000W 220 Volt 50 Hz	$ 1.342.000.-	$ 1.596.980.-
15243000	INVERSOR **PHOENIX** SINUS 24 V 3000W 220 Volt 50 Hz	$ 1.342.000.-	$ 1.596.980.-
15245000	INVERSOR **PHOENIX** SINUS 24 V 5000W 220 Volt 50 Hz	$ 1.987.000.-	$ 2.364.530.-
15485000	INVERSOR **PHOENIX** SINUS 48 V 5000W 220 Volt 50 Hz	$ 1.987.000.-	$ 2.364.530.-

INVERSORES DE ONDA SINUSOIDAL PURA CON CARGADOR DE BATERÍAS

15209800	INVER. **MULTI PLUS** 12V 800 W con cargador de 35 AMP	$ 718.000.-	$ 854.420.-
15209824	INVER. **MULTI PLUS** 24V 800 W con cargador de 16 AMP	$ 718.000.-	$ 854.420.-
15201200	INVER. **MULTI PLUS** 12V 1200 W con cargador de 50 AMP	$ 899.000.-	$ 1.069.810.-
15201224	INVER. **MULTI PLUS** 24V 1200 W con cargador de 25 AMP	$ 899.000.-	$ 1.069.810.-
15201600	INVER. **MULTI PLUS** 12V 1600 W con cargador de 70 AMP	$ 1.020.000.-	$ 1.213.800.-
15241600	INVER. **MULTI PLUS** 24V 1600 W con cargador de 40 AMP	$ 1.020.000.-	$ 1.213.800.-
15201695	INVER. **MULTI PLUS** 12V 3000 W con cargador de 120 AMP	$ 1.576.000.-	$ 1.875.440.-
15201698	INVER. **MULTI PLUS** 24V 3000 W con cargador de 70 AMP	$ 1.576.000-	$ 1.875.440.-
15201699	INVER. **MULTI PLUS** 48V 3000 W con cargador de 35 AMP	$ 1.576.000-	$ 1.875.440.-
152450120	INVER **MULTI PLUS** 24V 5000 W con cargador de 120 AMP	$ 2.135.000-	$ 2.540.650.-
154850070	INVER. **MULTI PLUS** 48V 5000 W con cargador de 70 AMP	$ 2.135.000-	$ 2.540.650.-
154858200	INVER. **QUATTRO** 24V 8000 W con cargador de 200 AMP	$ 3.338.000.-	$ 3.972.220.-
154858300	INVER. **QUATTRO** 48V10000 W con cargador de 140 AMP	$ 3.655.000.-	$ 4.349.450.-

INVERSORES DE ONDA SINUSOIDAL PURA CON REGULADOR DE CARGA , cargador de batería y permite la inyección de los excedentes a la red publica

15203000	**Ingecon sun storage 1 Play 3 TL** 48V 3 kW c/cargador de 50 A	$ 2.350.000.-	$ 2.796.500.-
15206000	**Ingecon sun storage 1 Play 6 TL** 48V 6 kW c/cargador de 50 A	$ 2.820.000.-	$ 3.335.800.-

Nota 1.- **Regulador de carga incorporado 3 TL para 6,5 kW y 6 TL para máximo 10 kW DC**
Nota 2**.- Opción para conexión en paralelo Monofásico y Trifásico**

CARGADORES DE BATERIAS Y CONVERTIDORES DC-DC

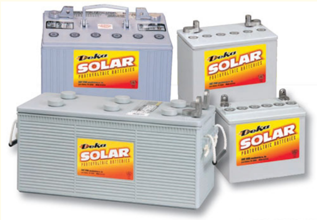
162016999	CARGADOR . **CENTAUR** 12/50 (3) de 12Volt 50 AMP	$ 430.000.-	$ 511.700.-
162016886	CARGADOR . **CENTAUR** 12/60 (3) de 12Volt 60 AMP	$ 448.000.-	$ 533.120.-
162016880	CARGADOR . **CENTAUR** 12/80 (3) de 12Volt 80 AMP	$ 739.000.-	$ 879.410.-
162016940	CARGADOR . **CENTAUR** 24/40 (3) de 12Volt 40 AMP	$ 694.000.-	$ 825.860.-
162016980	CARGADOR . **CENTAUR** 24/60 (3) de 24Volt 60 AMP	$ 794.000.-	$ 944.860.-
162016950	CARGADOR . **SKYLLA** TG 24/50 1+1 de 24Volt 50 AMP	$ 746.000.-	$ 887.740.-
162016912	CARGADOR . **SKYLLA** -i 24/80 (3) de 24Volt 80 AMP	$ 1.224.000.-	$ 1.456.560.-
162450100	CARGADOR . **SKYLLA** TG 24/100 1+1 de 24Volt 100 AMP	$ 1.479.000.-	$ 1.760.010.-
164850025	CARGADOR . **SKYLLA** TG 48/25 1+1 de 48Volt 25 AMP	$ 896.000.-	$ 1.066.240.-
164850050	CARGADOR . **SKYLLA** TG 48/50 1+1 de 48Volt 50 AMP	$ 1.600.000.-	$ 1.904.000.-

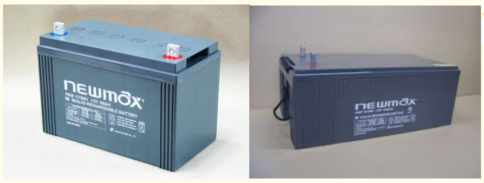
164812360	CONVERTIDOR DC-DC. **ORION** 12/24 de 15 AMP 360W	$ 238.000.-	$ 283.220.-
164850360	CONVERTIDOR DC-DC **ORION** 24/12 de 30 AMP 360W	$ 238.000.-	$ 283.220.-
164850015	CONVERTIDOR DC-DC **ORION** 48/24 de 15 AMP 360W	$ 238.000.-	$ 283.220.-

Lista de accesorios de productos Steca y Victron energy en última página.

CEEZ

BATERIAS DE CICLO PROFUNDO 12 VOLT DEL TIPO AGM, GEL BANCOS DE BATERIAS PARA USO INDUSTRIAL





CODIGO	DESCRIPCIÓN	VALOR S/IVA	VALOR 19% IVA
15153100	Baterías MEGATRON 100 A/h MG-27DC 12 V plomo acido sellada USA	$ 103.000.-	$ 122.570.-
15152100	Batería DEKA SOLAR GEL 8G31DT de 98 A/h en 12 Volt made USA	$ 239.000.-	$ 284.410.-
15152200	Batería DEKA SOLAR GEL 8G8D de 225 A/h en 12 Volt made USA	$ 565.000.-	$ 672.350.-
15182100	Batería NEWMAX GEL SG1000H de 100 A/h en 12 Volt made Corea	$ 145.000.-	$ 172.550.-
15182200	Batería NEWMAX GEL SG2000H de 220 A/h en 12 Volt made Corea	$ 339.000.-	$ 403.410.-

Nota: Las baterías de ciclo profundo no tienen descuentos

BOMBAS DE AGUA DE CORRIENTE CONTINUA DE SUPERFICIE Y POZO PROFUNDO

15149406	Bomba **2088-443-144** superficie SH 12V 15 lt/min 45 PSI 25 mts	$ 94.000.-	$ 111.860.-
15149401	Bomba **2088-474-144** superficie SH24 24V 15 lt/min 45 PSI 25 mts	$ 98.000.-	$ 116.620.-
15150665	Bomba **8002-793-238** superficie SH2 12V 7 lt/min 100 PSI 70 mts	$ 107.000.-	$ 127.330.-
15150660	Bomba **8007-593-836** superficie SHB 12V 7 lt/min 60 PSI 35 mts	$ 107.000.-	$ 127.330.-
15149408	Bomba **2088-573-534** superficie SHR 12/24V 7/15 lt/min 45 psi 30 mts	$ 180.000.-	$ 214.200.-
15149415	Bomba **2088-343-435** sup 12V 11,3 lt/min 50 psi 28 mts Válvula VITON	$ 105.000.-	$ 124.950.-
15150761	Bomba **SHURFLO 9300** SUMERGIBLE 12/24V 100psi 70 mts	$ 712.000.-	$ 847.280.-
15150761	Controlador optimizador **SHURFLO** modelo 902-100 con Float Switch	$ 125.000.-	$ 148.750.-

Nota: Valores sujetos a cambio sin previo aviso

Lámparas, Luminarias Públicas y Focos de bajo consumo En corriente continua 12 VOLT

SA1

SJ6M

PAR38-99LED

Globo 7W

Bajo C 7 y 11W

LED Corn 4W

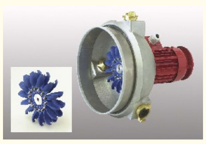
MR16-12LED

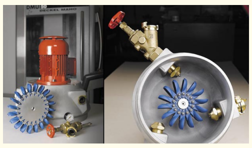
MR16-15LED

CODIGO	DESCRIPCIÓN	VALOR S/IVA	VALOR 19% IVA
15151186	Lámparas eficientes de bajo consumo Calida E-27 7W 12 Volt	$ 5.900 .-	$ 7.021.-
15151184	Lámparas bajo consumo tipo Globo Calida E-27 7W 12 Volt	$ 5.900.-	$ 7.021.-
15151182	Lámparas eficientes de bajo consumo Calida E-27 11W 12 Volt	$ 5.900.-	$ 7.021.-
15151183	Lámpara **12LED** tipo globo de luz blanca 12 Volt 1.17 W	$ 5.500.-	$ 6.545.-
15149115	Lámparas **MR16-15 LED** Luz Blanca 12 Volt 1.44 W - 57LM	$ 5.500.-	$ 6.545.-
15149104	Lámparas **LED Corn - 4** Luz Blanca 12 Volt 4 W E-27	$ 15.000.-	$ 17.850.-
15149199	Foco **PAR38-99 LED** LUZ Blanca 12 Volt 9 W - 374 LM	$ 19.000.-	$ 22.610.-
15181902	**Luminaria Publica** SA1-18 de 18W en 12Volt Philips Led 1750 lm/W	$ 95.000.-	$ 113.050.-
15181901	**Luminaria Publica** SJ6M de 56W en 12Volt Philips Led 5600 lm/W	$ 210.000.-	$ 249.900.-

LINGENHÖHLE TECHNOLOGIE

Micro Turbinas Hidroeléctricas desde 100 a 1000W para cargas de 24Volt DC





1515900	**MICRO TURBINA** KT100 100W en 36 Volt AC con rectificador AC/DC y regulador MPPT MX60 Hmax 35 mts / Hmin 3 mts / Qmax 3,5 l/seg / Qmin 0,5 l/seg	$ 3.299.000.-	$ 3.925.810.-
1515902	**MICRO TURBINA** KT340 340W en 36 Volt AC con rectificador AC/DC y regulador MPPT MX60 Hmax 35 mts / Hmin 7 mts / Qmax 3,5 l/seg / Qmin 0,5 l/seg	$ 3.736.000.-	$ 4.445.840.-
1515901	**MICRO TURBINA** KT1100 1000W en 36 Volt AC con rectificador AC/DC y regulador MPPT MX60 Hmax 70 mts / Hmin 12 mts / Qmax 6 l/seg / Qmin 0,5 l/seg	$ 4.904.000.-	$ 5.835.760.-

Además deberá considerar el banco de batería 24Volt, inversor según necesidad, como también los materiales eléctricos y la mano de obra para la instalación.

primuswindpower

Generadores Eólicos

Air-X Marine

171858 Generador AIR X marine 400 Watt 12 Volt DC	$ 1.188.000.-	$ 1.413.720.-
171859 Generador AIR X marine 400 Watt 24 Volt DC	$ 1.188.000.-	$ 1.413.720.-

* Los generadores Eólicos AIR-X 400 tienen regulador incorporado, se debe considerar además las baterías, inversor, etc, ver componentes en la lista.

No incluye la mano de obra para la instalación que dependerá de las características del lugar y de la ingeniería de detalle, como tampoco el poste metálico para la turbina.

Nota: Valores sujetos a cambio sin previo aviso

CEEZ

ACCESORIOS PARA EQUIPOS

1.- **Accesorios STECA SOLAR**

www.stecasolar.com

CODIGO	DESCRIPCIÓN	VALOR S/IVA	VALOR 19% IVA
15170102	**PA TARCOM 01** Data loger para conexión a PC	$ 494.000 .-	$ 587.860.-
15170103	**PA TARCOM RMT** Data loger para conexión vía Modem	$ 1.044.000.-	$ 1.242.360.-
15170104	**PA TARCOM GSM** Data loger para conexión GSM	$ 1.023.000.-	$ 1.217.370.-
15170105	**PA TARCOM ETHERNET** Data loger vía Ethernet	$ 845.000.-	$ 1.005.550.-
15170106	**PA CAB1** cable de conexión para PC con lectura tiempo real	$ 68.000.-	$ 80.920.-
15149341	**CONTROLADOR DE PARTIDA PA15** para TAROM 15 A	$ 120.000.-	$ 142.800.-
15170107	**PA RC100** Programador para Reguladores Solsum, PRS, Mppt	$ 155.000.-	$ 184.450.-
15149342	**PA HS200** SENSOR DE CORRIENTE Shunt para Tarom	$ 298.000.-	$ 354.620.-
15170000	**STECA GRID AC CONECTOR** Macho para 300 y 500	$ 2.000.-	$ 2.380.-
15170001	**Display ALD 1 visor Potencia Inyectada** Steca Grid 300 y 500	$ 64.000.-	$ 76.160

2.- Accesorios Victron Energy

www.victronenergy.com

15170108	**MK2-USB** Victron Interface para Multi plus y Quattro	$ 64.000.-	$ 76.160.-
15170118	**Victron Ethernet Remote** para monitoreo remoto	$ 489.000.-	$ 581.910.-
15170120	**BMV-600S** Monitor de Batería con Shunt y relé contacto seco	$ 135.000.-	$ 160.650.-
15170109	**BMV-700** Monitor de Batería con Shunt y relé contacto seco	$ 135.000.-	$ 160.650.-
15170110	**BMV-702** Monitor de Batería con Shunt y relé contacto seco	$ 178.000.-	$ 211.820.-
15170140	**BMV-700H** Monitor de Batería con Shunt y relé contacto seco	$ 684.000.-	$ 813.960.-
15170145	**Color Control GX**	$ 488.000.-	$ 580.720.-
15170111	**MC4** conector macho y hembra de 1 metro con cable 4mm2	$ 9.900.-	$ 11.781.-

Nota: Valores sujetos a cambio sin previo aviso

Asumiendo un comportamiento lineal de los dos termoventiladores, se tiene que:

Volumen Total Invernadero(m3)	**85**
Caudal(m3/h)	**100**

Tiempo en cubrir el volumen Total (hr)	**Tiempo en cubrir el volumen Total(min)**
0.85	**51**

El caudal efectivo entregado por los termoventiladores será de 100 m3/h; es decir, el aire interno será removido en su totalidad en aproximadamente 51 minutos. Este cálculo es cuando el equipo esté entregando toda su potencia nominal.

Debido al empleo del control proporcional, la potencia entregada por los termoventiladores es dependiente de la diferencia entre la temperatura ideal y la temperatura actual del invernadero.

Es por ello que se asume que habrá solo 2 remociones del aire total interno del invernadero. Esto se dará en horas de la madrugada cuando la temperatura alcance sus niveles más bajos.

Estas dos remociones de aire implican que el uso de los termoventiladores será de 2 horas al día aproximadamente entregando toda su potencia nominal.

Diagramas de Pistas del Circuito Prototipo