Microcosm Ethernet Transceiver MC4663

Complete pure-CMOS Transceiver for 10Base-FL Ethernet

Main Features:

- **Low cost, single chip solution**, available in a 28PLCC **or the new 28SSOP package**. Compatible, superior replacement for Industry-standard IC. (See applications information).
- **Full-custom, deep-sub-micron CMOS** technology for high reliability and lowest power consumption. (Complete MAU current consumption approx. 140mA; allows linear regulator)
- Input sensitivity of 2mV and 62dB dynamic range. **System sensitivity of -36dBm with recommended MC2003ST photoreceiver.**
- **Resistor-programmable 100 mA LED driver, allows lower-cost LEDs**
- On-chip AUI driver/receivers.
- Single +5 V operation
- Clock generated internally on chip.
- 5 status LED drivers.

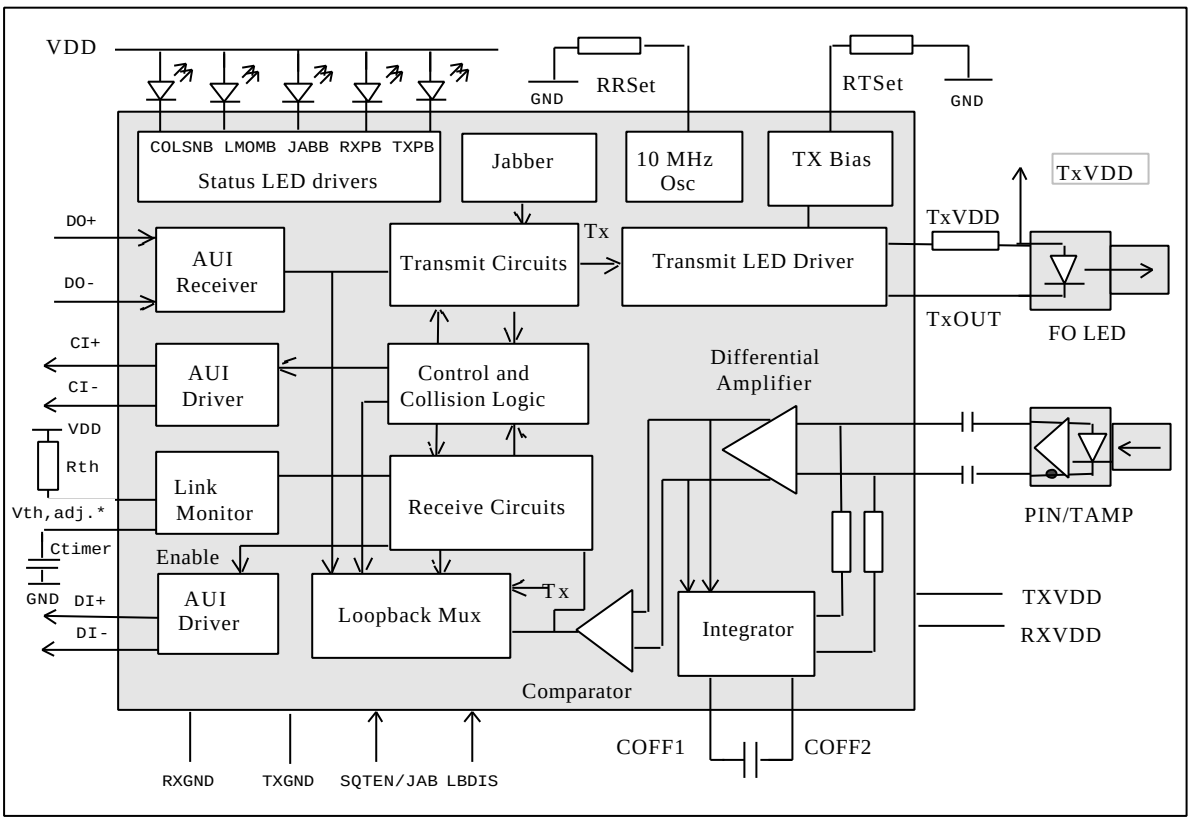
Low-cost 10Base-T to FL converter (Pg. 4)

General Description:

The MC4663 is a full-custom CMOS IC for Ethernet transmission over optical fiber. The IC can be used as the heart of a **IEEE 802.3 10BASE-FL** transceiver in conjunction with a minimal number of additional components.

The MC4663 is PCB-compatible with the industry-standard part, allowing new PCB designs to accommodate both ICs. The application diagram (page 5) shows typical external configurations including linear voltage regulator. Being CMOS, the MC4663 allows lower cost power supply components to be used.

The MC4663 interfaces with standard '1414' type FO LED components. And where the **recommended Microcosm MC2003ST Photoreceiver** is used, an extra 2dBm optical sensitivity is typically shown over previous solutions.



General Transmitter and Receiver Functions

The MC4663 consists of separate and independent transmit and receive paths, plus collision detect and loopback.

Transmit path

Differential input data from the AUI port is connected to the MC4663 TxD inputs (Tx+, Tx-) via an isolation transformer. This data controls the LED drive current switch, subject to TxD data squelch criteria. When Tx+ is positive with respect to Tx- then the fiber optic LED will be in the "lower-light" condition, in essence switched off. When Tx+ is negative with respect to Tx- then the fiber optic LED will be in the "higher-light" condition, therefore, switched on.

The TxD squelch prevents the propagation of noise onto the fiber. The squelch criteria are:

- i) The minimum data pulse width is 20ns.
- ii) The level is less than 250 mV.

Once the TxD is unsquelched the squelch is turned-on again when an input signal is received at Tx+ and Tx- that is more positive than 250mV for at least 180 ns.

The maximum delay from detection of a valid Ethernet packet at Tx and propagation to the LED driver is 2 data bits or 200 ns. Data bits received at the Tx interface during this detection period will not be reproduced at the LED driver. When no data is detected on the Tx interface, a 1 MHz (typical) idle signal is output at the LED driver.

The LED driver consists of a current mode switch which sinks current through the LED via the TxOUT pin when "on" and through the TxVCC pin when "off". The "on" current level is determined by the resistor value RTSET. See section headed *Setting the transmit current.*

Receive Path

The receiver accepts an input from a Photoreceiver component containing a PIN diode and transimpedance amplifier. Either Single-ended or differential output (Microcosm type - MC2003) Photoreceivers may be used. However, differential output types are strongly recommended as these will offer better noise immunity, with the dominant common-mode noise being rejected.

The transimpedance amplifier output is AC coupled to the MC4663 via 1nF capacitors. If only a single-ended output is available, the 'loose' MC4663 input should be coupled via 1nF capacitor close to the Vcc of the photoreceiver.

The input stage of the MC4663 comprises a limiting differential amplifier and quantizer. The input sensitivity is typ. 2mV with a dynamic range of 62dB.

The receive path includes squelch circuitry and a low light level monitor. The receiver squelch will reject frequencies lower than 2.5 MHz, and is activated by the idle signal which follows the transmission of a packet.

The light level monitor is a way of maintaining the integrity of the network from the consequences of a fiber optic link failure. When a light level below that required for reliable reception is detected, the MC4663 will enter the "Link Test Fail" (LTF) state and the LMON LED will go off. When in the LTF state, data bit transfers to Transmit, Receive and Loopback functions are inhibited. In addition, the LTF state will cause the collision presence and SQE test functions to be inhibited.

The MC4663 is designed to be compatible with the ML4663 when Vth, adj. is left floating. However, this severely limits the possible vendors of optical components. Microcosm therefore strongly recommends Vth, adj. is set by connecting a fixed resistor, Rth, between Vth, adj. and VDD. (see Page 5). The value of Rth will be constant for any particular vendor's PIN-AMP.

The maximum delay from the start of a receive packet to the detection of a Ethernet packet is 2 data-bits. Data received during this detection period will not be reproduced at the output AUI Rx interface.

Collision

A collision will occur when data appears at the AUI Tx interface concurrently with data at the optical receive interface. Within 3.5 Ethernet data bits of a collision occurring, a 10 MHz (typical) clock will be asserted on the AUI COL interface.

The same 10 MHz square wave will be asserted on the AUI interface for the duration of the SQE test and when the Jabber is active.

Loopback

When the transmit path of the MC4663 is active the data appearing presented to the AUI Tx interface is looped back to the AUI Rx interface. This facility is used by some LAN controllers to ensure that a Medium Attachment unit (MAU) is connected to the network.

Loopback is automatically disabled by when the "link test fail" (LTF) condition is detected and when the jabber is active.

Loopback can be permanently disabled using the LBDIS. When LBDIS = VDD, loopback and collision detect are disabled. In this mode the MC4663 functions simply as a full-duplex transceiver. The normal LBDIS setting (to comply with 10BASE-FL) is LBDIS = GND. It is important that LBDIS is not allowed to float.

Signal Quality Error (SQE) test

The Signal Quality Error (SQE) test is performed by MAU's which are connected to DTE's and not for MAU's connected to repeaters. The SQE test provides a way of testing the collision circuitry. When enabled the SQE test is performed after the completion of each transmit packet in the inter-packet gap. The SQE test is sustained for approx. 800ns (9 SQE clock cycles) after a wait time of approx. 1µS.

When the MC4663 is used to interface with a DTE then SQEN = VDD, so that the SQE test is enabled. When the MC4663 is used to interface with a repeater then SQEN = GND so that the SQE test is disabled.

Jabber

The Jabber function is essentially an internal watchdog which monitors the length of each transmit packet. The Jabber's function is to prevent a persistent transmitter hogging the network. If the transmit packet exceeds a critical maximum time, then the watchdog inhibits the loopback function and transmissions at the fiber interface (LED driver) and will also asserts a 10 MHz SQE wave on the AUI COL interface.

The critical maximum time for a transmit packet is between 78 mS (typical). This complies with the 10 BASE-FL standard specification of 20 ms to 150 ms. Once the Jabber function has been invoked the device will remain in the Jabber state until an idle signal is detected on the AUI Tx interface for 0.36 s (typical).

SQTEN/JAB	Jabber	SQT
VDD	On	On
GND	On	Off
FLOATING	Off	Off

Table 1 showing possible logic states for SQTEN/JAB

Status LED Drivers

The MC4663 has 5 status LED drivers LMONb, JABb, RCVb, XMTb and COLSNb.

LMONb: Link Monitor. LED illuminates when the light level is above the minimum to sustain a reliable link.

JABb: Jabber Active. LED illuminated when Jabber is activated.

RCVb: Receive Packet. LED is illuminated when receive packet is in progress.

XMTb: Transmit packet. LED is illuminated when transmit packet in progress.

COLSNb: Collision. LED is illuminated when a collision is detected.

The drivers consist of pull-down transistors. The Indicator LEDs are connected between the driver pins and the VDD supply via 510Ohm resistors.

The LMONb and the JABb condition remain for sufficient time so that the status LEDs are visible to the human eye. The RCVb, XMTb and COLSNb drivers include timers (pulse stretchers) to ensure that the LED is driven for at least 5 ms (typical). If a new condition arises before the timer expires then the timer is re-triggered. In order to facilitate the connection of electronic counters to status pins RCVb, XMTb and COLSNb the outputs will go inactive for 100 ns following each trigger. This means that an edge triggered counter will be able to accurately record the status count.

Clock - RRSet

The timing is controlled by an internal clock generator. The clock frequency which must be 10 MHz (± 15%) is controlled by a external resistor, RRSet, with a tolerance of 1%. RRSet should be 27 kohms (nominal).

Setting the Transmit Current - RTSet

The transmit current to the LED can be set with RTSET, the current setting resistor. The LED drive current is then given by:

ILED*= 125/RTSet where RTSet > 1 KOhms ,

*** current tolerance ±20 % using 1% RTSet resistors.**

For ML4663 compatibility, RTSET can be 2.2K ohms. However, to take advantage of lower-cost LEDs, the LED drive current can be increased up to 100mA.

When the LED is nominally 'off' a trickle current, at 3 % of the peak current set by the user, continues to flow. This improves the LED switching characteristics and complies with the 10Base-FL maximum extinction ratio.

Setting the Low-Light level - Threshold adjust option

The 10BASE-FL specification dictates that the system (MC4663 + optical receiver) must achieve a BER of at less than 10^{-9}, at the optical power* level of -32 dBm. In addition, when the optical power level falls below the level which corresponds to a BER of 10^{-9} for more than 2000 Ethernet bit periods, then the Link Test Fail (LTF) state is entered.

The performance of the receiver PIN-diode and associated transimpedance amplifier will vary from one supplier to another, and from batch to batch from a single supplier. For optimum performance Microcosm strongly recommends the threshold should be set using a resistor, Rth, connected between Vth, Adj. and VDD as shown in the application schematic on page 5. Rth will typically be 2.2MOhms, depending on the gain in the PIN-AMP. It will be constant for any particular supplier's PIN-AMP.

PIN-Amp	Gain, typ.	Rth
MC2003ST	22mV/µW	2.2MOhms

Table 2 showing example Rth value.

Regardless of how the threshold is set, the device will exit the LTF state once the optical power exceeds threshold (-32.5dBm nominal) for 0.36 seconds (typical). Exiting the LTF state and entering the Link Test Pass (LTP) state will be delayed until the idle signal is detected at both the AUI Tx interface and the optical receive interface.

Whilst the device is in the LTF state the following functions will be disabled: Transmit, Receive, Loopback, collision presence and SQE test.

Optical power for 10 BASE-FL is average optical power which for Manchester-encoded data is equivalent to (peak power - 3dBm)

AUI Interface

The MC4663 AUI interface comprises three pairs of differential signals. The Rx and COL output pairs and the Tx input pair.

The three pairs of signals are normally AC coupled through isolation transformers (except where the transceiver is internal). The output pairs require 220 ohm bias resistor (1% accuracy) connected to ground. These differential

outputs will then operate around a nominal DC voltage of (VDD - 2) Volts. The differential output voltage will be approximately +/- 0.65 Volts. When the output pairs are in the idle state both differential drivers are forced to the same voltage to prevent DC current flowing through the isolation transformers. The Tx input pair are internally DC biased to VDD/2 with a nominal input impedance of 5 Kohms. The correct termination may be provided by connecting a 78 ohm (1% accuracy) resistor (or 2x 39ohm resistors) between the Tx+ and Tx- terminals.

The Rx pair when active will either reproduce the data received at the fibre optic receiver interface or data looped back from the AUI Tx interface. The inactive state for the Rx interface is the idle state described above.

The COL pair when active, will output a 10MHz square wave. The inactive state for the COL interface is the idle state described above.

The Tx interface includes squelch circuitry which will prevents the propagation of noise beyond the squelch circuitry. The interface is more fully described in section headed *Transmit path.*

Manufacturers of LEDs & Photoreceivers

Microcosm, Honeywell, HP and Optek are among the manufacturers making suitable LEDs and Photoreceivers. **However, the Microcosm Photoreceiver offers the best margin over IEEE specifications.**

Please contact Microcosm if more assistance is required.

Power Supply Decoupling

The MC4663 contains highly sensitive amplifiers, capable of responding to extremely low current/voltage levels. To exploit this sensitivity it is important to reduce external noise to a low level compared to the input signal. The MC4663 should have an independent power trace to the point where power enters the board.

The Photoreceiver should be sited very close to the MC4663's input pins. A differential-output Photoreceiver, like the MC2003ST, will offer the best noise immunity. A generous ground plane should be provided, especially around the sensitive receiver. The device should be protected from EMI/RFI sources in the standard ways.

Socketing

Best results will be obtained when the MC4663 is soldered directly to the PCB.

Operating Voltage, Current

The MC4663 is designed to operate at 5 Volts ±5%. A typical complete MAU takes 140mA when the LED driver current is set to 60mA.

Compatibility with MicroLinear ML4663

The MC4663 and ML4663 are 'PCB compatible' if the PCB is designed with the few differences in mind:

Connection differences:

Vin+, Vin-

Connection and Value differences:

RTSET

RRSET

Ctimer

Vref/Vthadj.

Value differences:

AUI interface resistors

See the applications schematic on the following page.

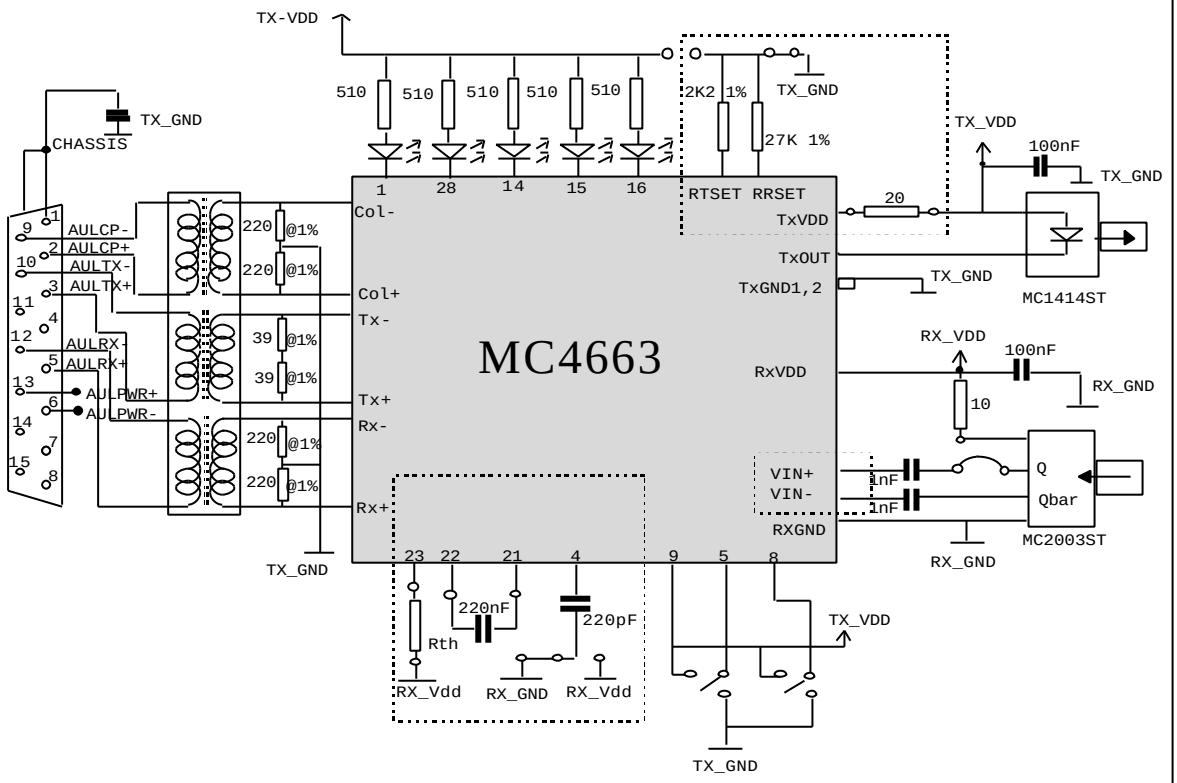
PLEASE NOTE the MC4663 will not function in an existing ML4663 PCB without these modifications.

10Base-T to FL converter

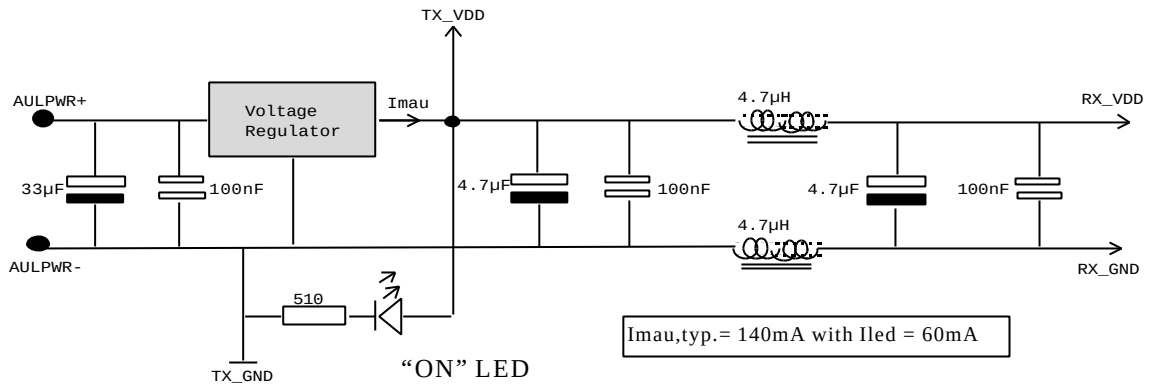
The MC4663 and SEEQ 83C95 IC make an excellent 2-chip 10Base-T to FL converter solution. *This is lower-cost, and better-performing than competing single-chip solutions.*

Check with Microcosm for applications information.

Schematic Diagram of MC4663 configured with Microcosm MC2003/1414 optical components.



PIN Number	MC4663	ML4663
21	COFF1	VDC
22	COFF2	Vref



Typical power supply circuit, using Linear Regulator.

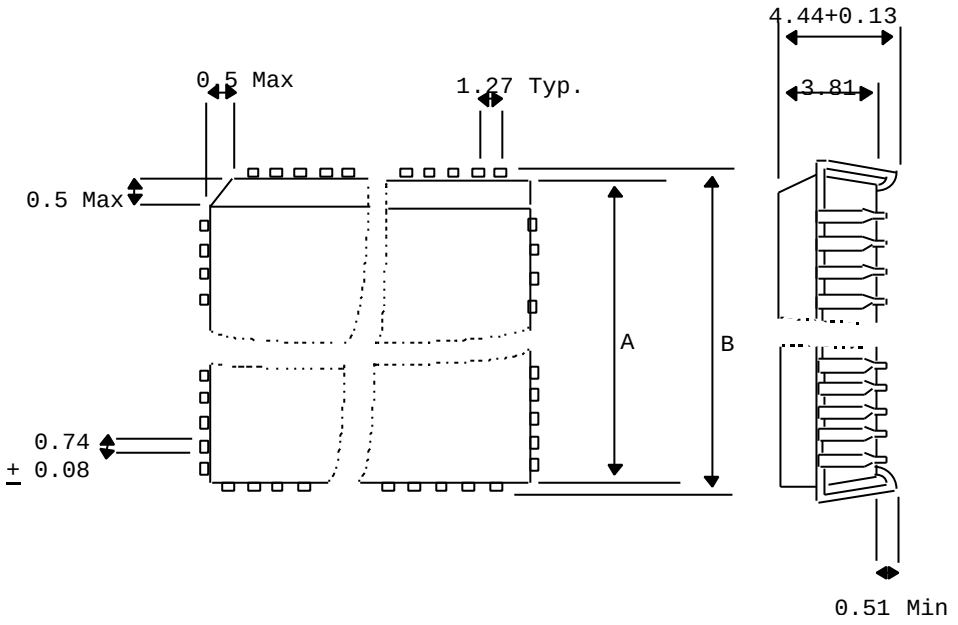


Figure 14. 28 Pin PLCC Package Dimensions

See Microcosm Package Guide for further details

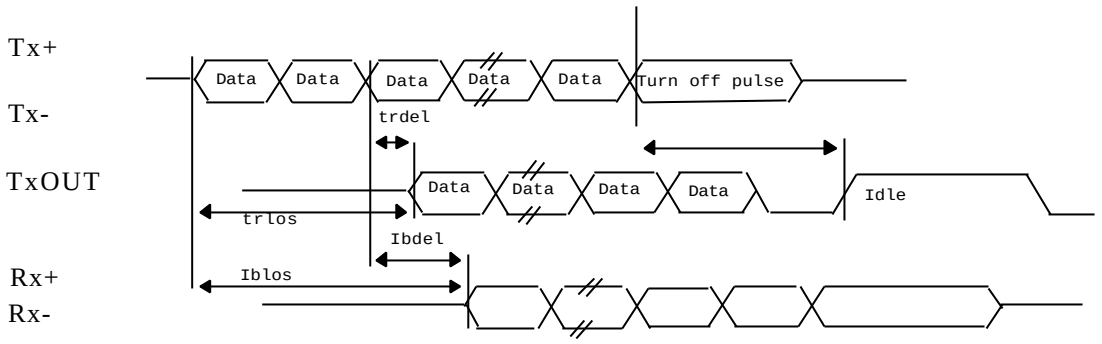


Fig 2 Transmit and loopback timing.

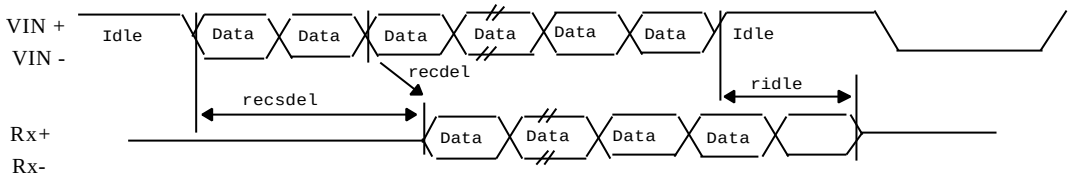


Fig 3 Receive path timing.

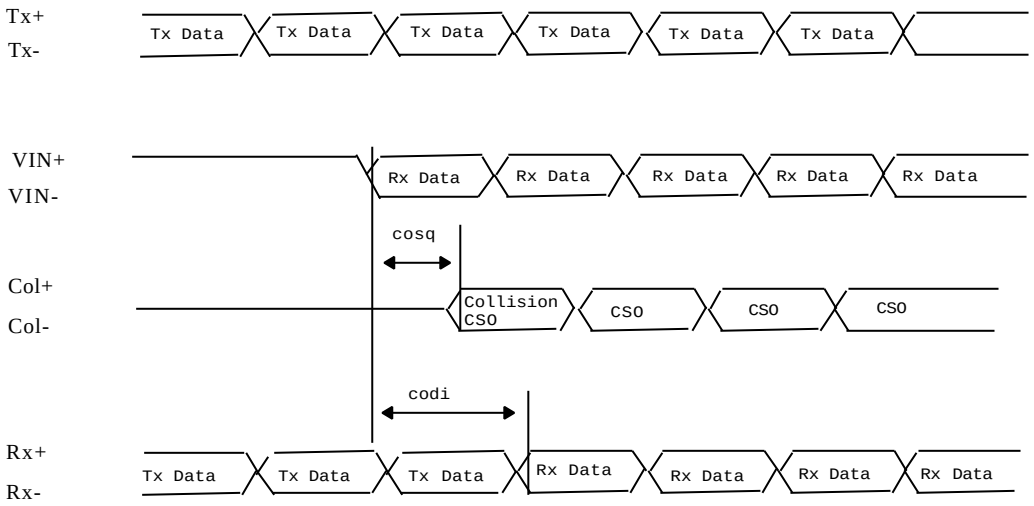


Fig 4 Collision detect timing with Transmit active before Receive.

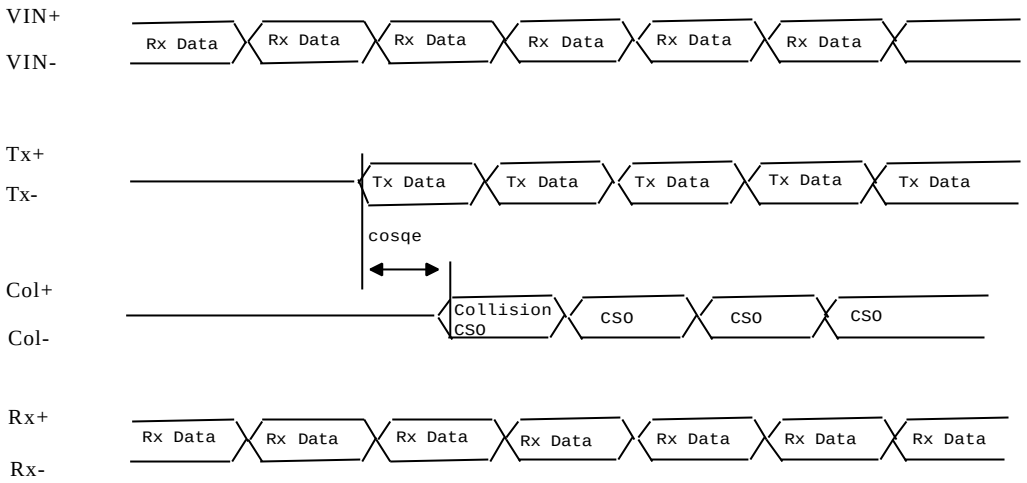


Fig5 Collision detect timing with Receive active before Transmit.

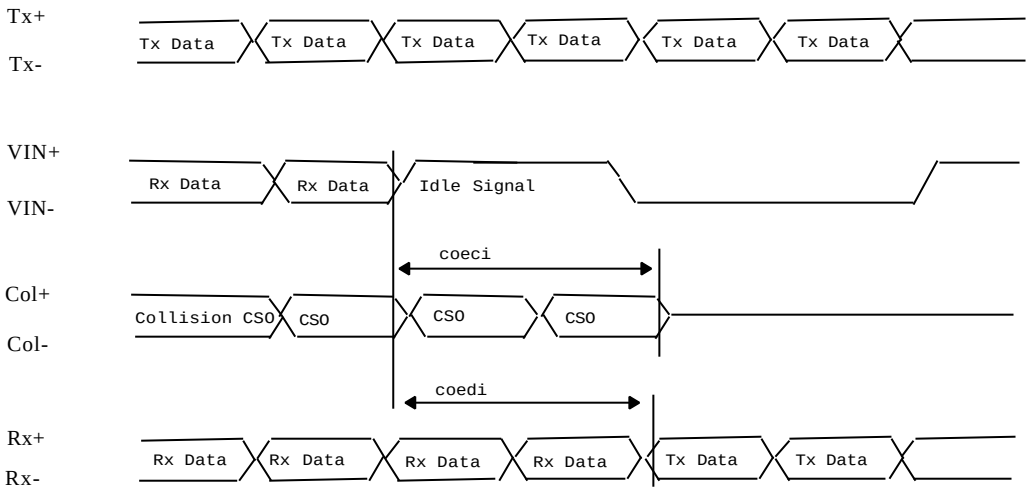


Fig 6 Collision end timing, with Receive activity terminating first.

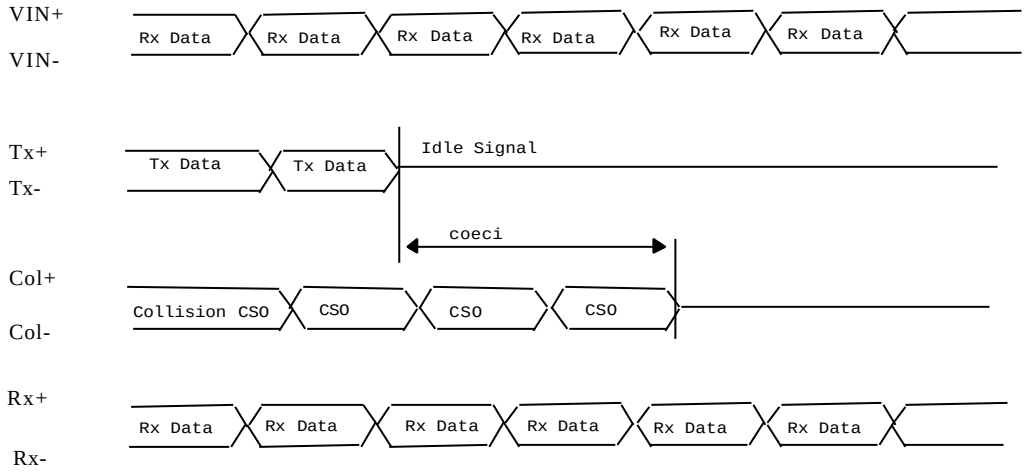


Fig 7 Collision end timing, with Transmit activity terminating first.

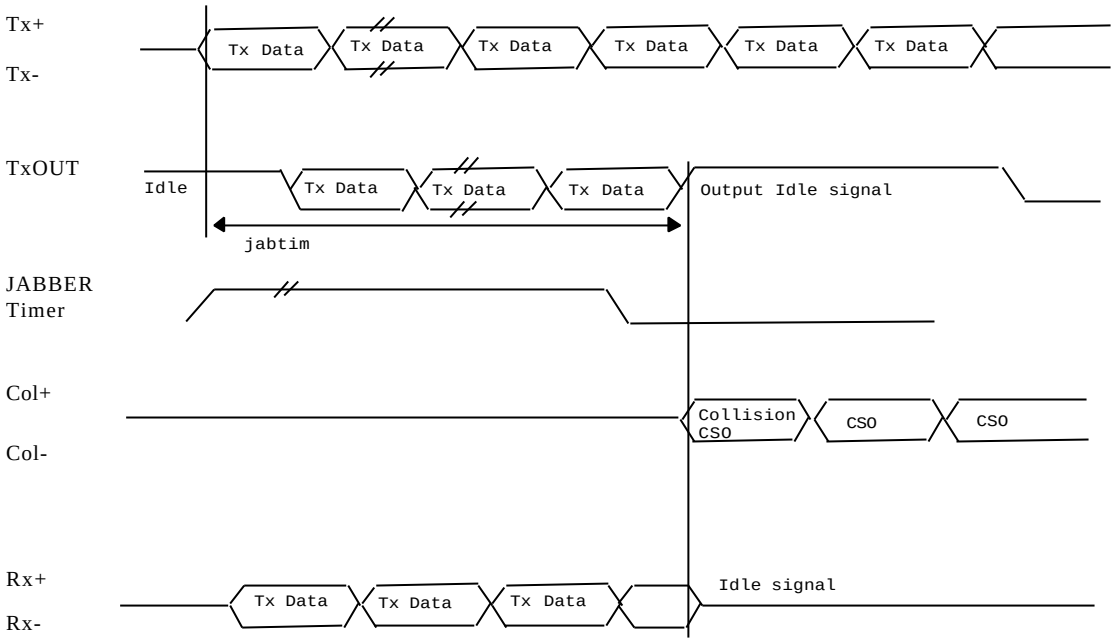


Fig 8 Jabber-on timing.

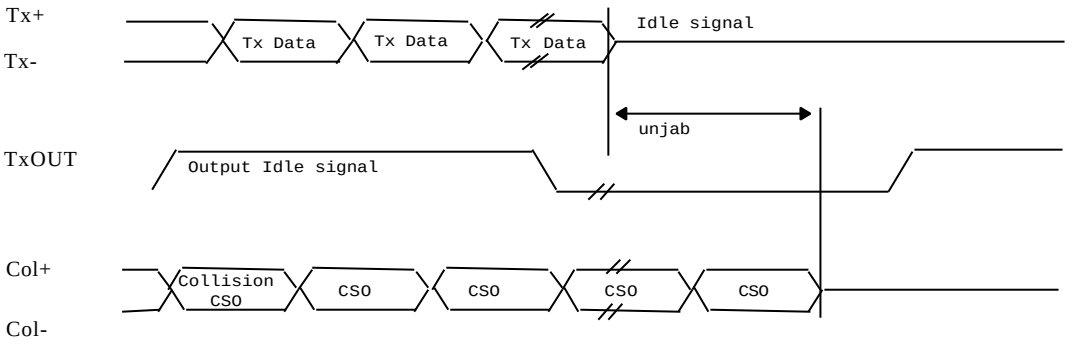


Fig.9 Jabber-off timing.

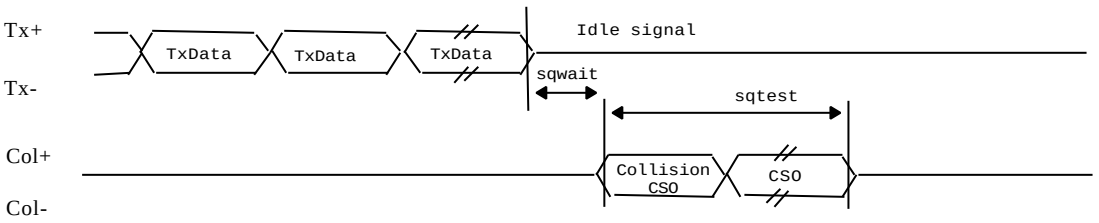


Fig.10 SQE test timing.

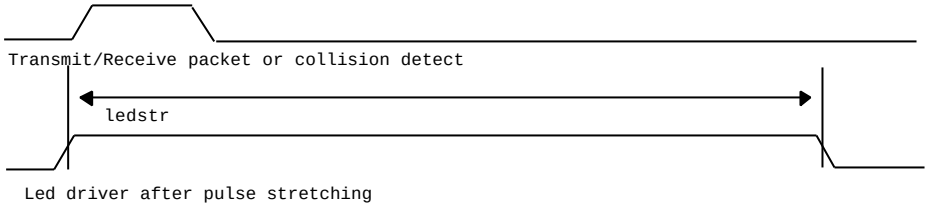


Fig.11 LED pulse stretcher for single shot XMTb, RCVb and COLSNb.

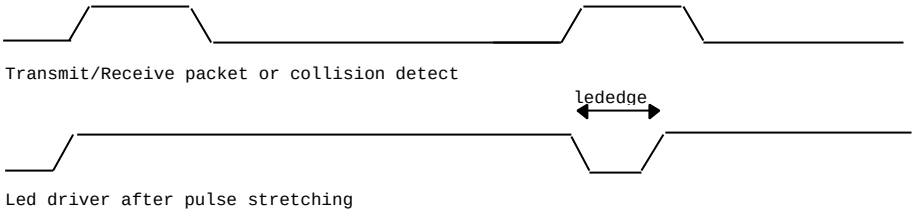


Fig.12 Led driver will go low for time 'lededge' if re-triggered before stretch timer expires.

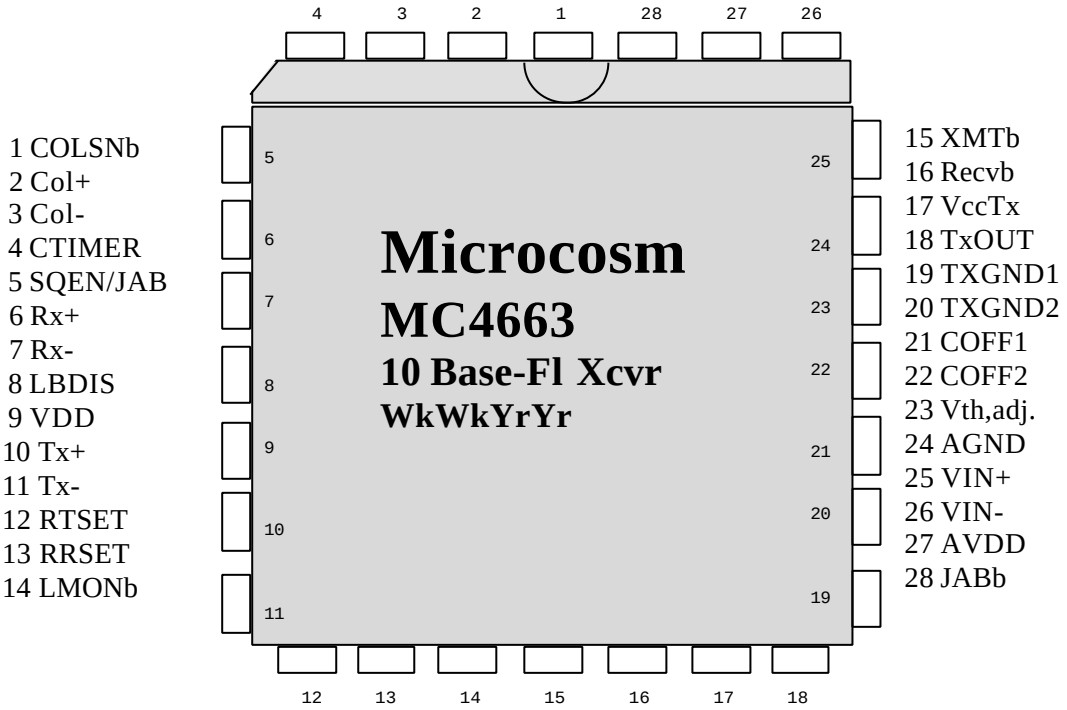


Figure 13. Pinout of the MC4663
Top view of 28PLCC package.
WkWkYrYr is the date code.

Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
Power supply (TXVDD, RXVDD)	VDD	-0.3	6.0	V
Storage temperature	Tstor	-50	160	ºC
Input Voltage Range Digital Inputs LBDIS & SQTEN	Vin	-0.3	VDD	V
Input Voltage Range Tx+/-, VIN+/- VTH, CLINK, PEAK, DIODE, COFF1, COFF2	Vin	-0.3	VDD	V
Input Current JABb, COLSNb, XMTb,RCVb,LMONb	Iind	-	60	mA
Input Current LDN , LDP	Iopin	-	130	mA
Output Current RTSET,RRSET	Ibias	-	10	mA

These are the absolute maximum ratings at or beyond which the IC can be expected to fail or be damaged. Reliable operation at these extremes for any length of time is not implied.

Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Power supply	V+	4.75	5.0	5.25	V
Ambient temperature range	TA	-40	-	85	ºC
Current consumption with LED driver output current = 55mA (Note1)	Icc	70	80	90	mA

Static Characteristics

Parameter	Symbol	Min	Typ	Max	Units
Vin High SQEN/JAB, LBDIS	Vindh	VDD - 0.5	-	-	V
Vin Low SQEN/JAB, LBDIS	Vindl	-	-	0.5	V
Vout Low (Iout = 10mA) LED Drivers: RCVb, TXBP, JABb, LMONb, COLSNb. (Note 2)	Volled	-	-	0.5	V
LED Transmit Peak Output Current. RTSET min value = 750 ohms RTSET max value = infinity	Ioled	80 -	100 0	120 -	mA
LED Transmit Peak Output Current. RTSET = nominal value = 1.5 Kohms	Ioled	40	50	60	mA
AUI Drivers Common Mode Output Voltage Rx+/-, COL+/-	Audcom	VDD-2.5	VDD-2.0	VDD-1.0	V
AUI Drivers Differential Output Voltage Rx+/-, COL+/-	Auddif	+/-550	-	+/-1200	mV
AUI Drivers Differential Output Voltage inbalance Rx+/-, COL+/-	Audib	-	-	+/-40	mV
AUI Receiver Squelch Voltage Level Tx+/-	Tvsq	-200	-250	-300	mV
AUI Receiver Common Mode Voltage Tx+/-	Aurcom	0.4*VDD	0.5*VDD	0.6*VDD	V
VIN+/- Differential Amplifier Gain	Again	40	50	60	V/V
VIN+/- Input Signal Range peak to peak	dr	2	-	2500	mV
VIN +/- Input Offset With DC loop active	IO	-	-	0.5	mV
VIN +/- Input Resistance	IR	1.5	2.0	2.5	kOhms
VTH Hysteresis	Vhy	-	1	-	dB

Note2 LED-indicator drivers are pull-down transistors.

Dynamic Characteristics: Transmit timings

Parameter	Symbol	Min	Typ	Max	Units
Optical LED on Current	Tledoc	-	-	120	mA
Optical LED off Current as percentage of on Current	Tledt	-	-	3	%
LDN rise time	Tledr	-	-	3	ns
LDN fall time	Tledf	-	-	3	ns
Transmit steady state delay	tdel	-	10	50	ns
Transmit start delay and number of header bits not transmitted	trlos	-	-	2	data bits
Transmit turn off delay from data to idle	trid	800	1100	1400	ns
Loopback steady state delay	lbdel	-	20	50	ns
Loopback start delay and number of header bits not looped back	lblos	-	-	4	data bits
Transmit idle frequency	Tidf	0.85	1	1.25	MHz
Transmit idle mark/space ratio	Tims	45	-	55	%

Dynamic Characteristics: Receive timings

Parameter	Symbol	Min	Typ	Max	Units
Receiver Squelch Frequency threshold	Rsthr	-	2.5	-	MHz
Receiver start delay and number of header bits not reproduced at Rx+/-	recsdel	-	-	2.5	data bits
Receiver steady state delay	recdel	-	10	50	ns
Receive data to idle delay	ridle	-	300	-	ns
Rx+/-, COL+/- Differential rise and fall time	Adrf	-	4	-	ns

Dynamic Characteristics: Collision timings

Parameter	Symbol	Min	Typ	Max	Units
Collision occurrence to SQE asserted at COL+/-	cosqe	-	-	350	ns
Collision occurrence to receive data asserted at Rx+/-	codi	-	-	500	ns
End of collision to COL+/- idle	coeci	-	-	500	ns
End of collision to Tx+/- data asserted at Rx+/-	coedi	-	-	500	ns

Dynamic Characteristics: Jabber timings

Parameter	Symbol	Min	Typ	Max	Units
Maximum Length of Transmit Packet	jabtim	40	78	125	ms
Unjab time	unjab	280	360	500	ms

Dynamic Characteristics: Squelch Test timings

Parameter	Symbol	Min	Typ	Max	Units
Time from end of Transmit to SQE Test	sqwait	0.75	0.9	1.2	us
SQE Test Duration	sqtest	0.7	0.8	1.1	us

LED-Indicator outputs

Parameter	Symbol	Min	Typ	Max	Units
Status LED Stretch Time	ledstr	4	5	6	ms
Status LED Low Time following re-trigger	ledge	70	100	130	ns

Contact Information

Microcosm Corporate Offices

Corporate Headquarters

Microcosm Communications Ltd
Castlemead
Lower Castle Street
Bristol BS1 3AG
England
Phone: (+44) 117 930 2400
Fax: (+44) 117 930 2401

World Wide Direct Sales

USA Sales Office

Microcosm Communications Ltd
10855 SW Falcon Court
Beaverton, OR 97007
USA
Phone: (503) 590-0540
Fax: (503) 590-3717
Email: steve0010@msn.com

European Sales Office

Microcosm Communications Ltd.
Castlemead
Lower Castle Street
Bristol BS1 3AG
England
Phone: (+44) 117 930 2400
Fax: (+44) 117 930 2401
Email: microcosm_communications@compuserve.com

Japan Sales Office

Microcosm Communications
793-9 Nakagawa
Omiya-city, Saitama 330-0831
Japan
Phone: (+81)-48-680-6102
Fax: (+81)-48-680-1656
Email: tatsuyuki.torii@csi.com

Asia Distributors

China/Hong Kong

WZT Corporation
5/F, HuaYing Building
Nan You Road
ShenZhen
China
Phone:(+86) 755-6646166
Fax: (+86) 755-6409678
Email: szwztlec@public.szptt.net.cn
Email: manager@wzt.com

Korea

UTO International Corp.
Union Center #801
837-11 Yeok-Sam Dong, Kang-Nam Gu
Seoul 135-080,Korea
Phone: (+82) 2-501-5665
Fax: (+82) 2-508-3250, (+82) 2-501-0023
Email: utokorea@elim.net
Email: utokorea@utocorp.com

Taiwan

Jeritronics Ltd
Floor 7F, No.267, Sec.3
Cheng-Teh Road
Taipei
Taiwan ROC
Phone: (+02) 2585 1636
Fax: (+02) 2586 4736
Email: jeritron@tpts1.seed.net.tw

Ordering Information

Part	**Pin–Package**
MC4663DIE	Waffle Pack
MC4663DIEW	Expanded Whole Wafer on a Ring
MC4663PL28	PLCC28
MC4663SS28	SSOP28