MM04

Inkjet Print Head Driver Module

RoHS COMPLIANT

FEATURES

- Supports
  - Ricoh GEN5 Print Head
  - Equivalent Print Heads
- UART or I2C Interface
  - Waveform Download
  - Temperature Monitor
  - System Information
- 4 Power-Analog Output Channels
  - Precisely Control Drop Formation
  - Output Voltage up to $34V_{PEAK-TO-PEAK}$
  - High Output Current: 1.5A continuous, 5.6A peak (per channel)
  - High Output Slew Rate: 15V/µs (min)
  - 80W Power Dissipation Capability (20W per channel)
  - Temperature Sense
- 4 Independent Waveform Generators
  - 10-bit Resolution
  - Waveform Information Stored in NV Memory
  - Up to 33 kHz Pulse Frequency
  - 125µs Maximum Length
- Automatic Start after Power-On (Configurable)
- Integrated Digital Printing Data Inputs
  - Control Drop Level Settings (8 gray-scale levels)
  - Up to 1280 Nozzles (4 rows of 320)
- Quick-Start GUI Available
  - Connects through I2C or UART
  - Easily Generate and Upload Waveforms
  - System Diagnostics

APPLICATION

- Industrial Inkjet Printers

DESCRIPTION

MM04 is an inkjet print head driver intended for use with the Ricoh GEN5 print head.

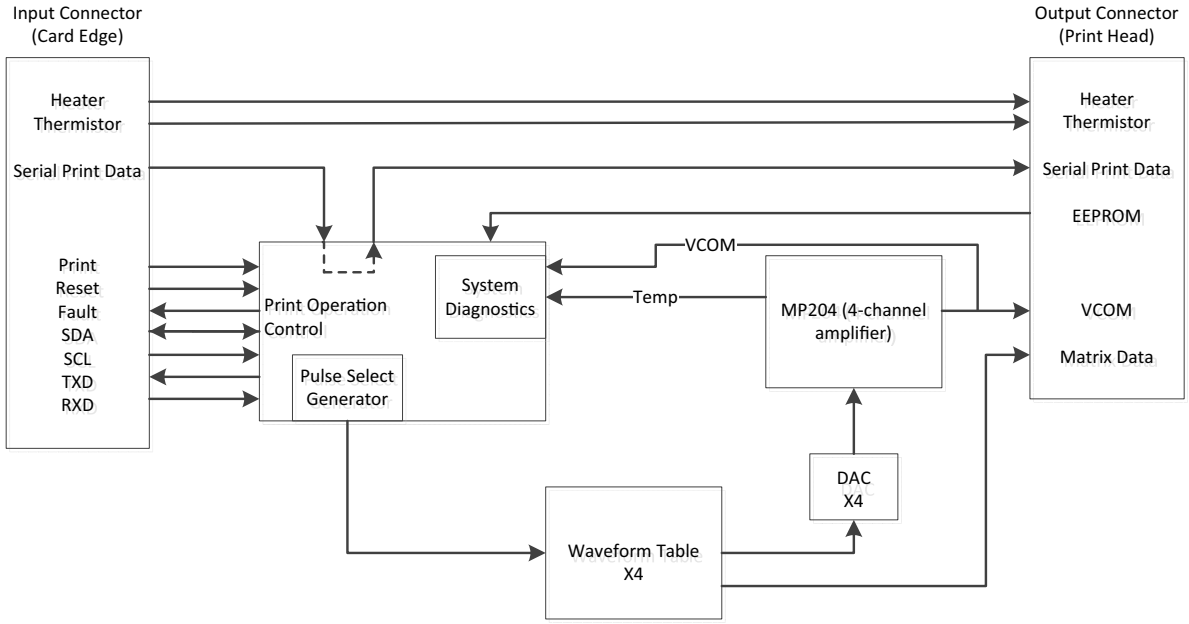
MM04 contains an analog and a digital section. The analog section consists of four independent power amplifiers, each of which is capable of producing the fire pulses needed to drive up to 1280 inkjet nozzles. The digital section uses 3-bit, digital printing data for the print head's output latches, and generates exactly timed analog input signals for the power op amps.

The analog section plugs into the digital section and is built on a thermally conductive but electrically insulating substrate that can be mounted to a heat sink. The digital section has a card edge connector for connection to a digital printing control system, and a side connector that accommodates the print head flex cable connector.

OVERVIEW

BLOCK DIAGRAM

Figure 1: Block Diagram



BLOCK DESCRIPTION

Block	Description
Waveform Table	Lookup table with D/A converter values. For every waveform output, a state machine runs through the table for the related output channel, updating the external D/A converter periodically with the next value from the table. The waveform tables are stored in Non-Volatile RAM in the module, so that the module can start its operation without a waveform download after power-on.
Waveform DAC	D/A converter. Feeds analog signals into Power Amplifier MP204.
System Diagnostics	Checks for a proper operation environment of the module. Checks include temperature and supply voltage monitoring.
Print Operation Control	System control. Sets the operational mode of the module (on-line, off-line, demo mode), communicates system health information (supply voltages, temperature) and handles the download of waveforms to the module.
Pulse Select Generator	Sets the selection matrix of the print head based on a look-up table. The look-up table defines the selection matrix for each of the 8 intensity values per pulse. For Ricoh GEN5, the pulse selection is communicated to the print head as an 8-bit serial synchronous communication.
MP204	4-channel Power Amplifier. Provides high-current waveforms to VCOM for each Print Head Channel.

ABSOLUTE MAXIMUM RATINGS

The following ratings apply to the MM04 system. For specific electrical characteristics of the analog portion, see MP204 datasheet.

Parameter	Symbol	Min	Max	Unit
Supply Voltage, $+V_S$	$+V_S$	20	34	V
Digital Supply Voltage, V_{CC}	V_{CC}		5.5	V
Fire Pulse Output Current, peak, (within SOA)[1]	$I_{OUT}(pk)$		5.6	A
Power Dissipation, internal [1]	P_D		20	W
Temperature, junction	T_J		150	°C
Temperature Range, storage	T_S	-40	105	°C
Operating Temperature Range, case	T_C	-25	85	°C

1. Rating applies to each amplifier channel. Output current is internally limited by the MM04 using the current limit function of MP204. This value cannot be changed.

PRINCIPLES OF OPERATION

MM04 is designed to allow easy integration of pulse timing and waveform generation with digital inkjet print head control. Using the MM04 requires 2 steps: setting up the waveform data, and sending serial printing data to the print head.

On the print head side, the waveform data dictates how the ink is ejected from the nozzles. The serial data is stored in the print head's internal registers and determines the drop level settings.

SETTING UP WAVEFORMS

To set up the waveform data in the MM04's waveform table, use either I2C or UART protocol to write new information to the waveform table. The MM04 Manager GUI provides an easy platform for editing waveform shapes and uploading them. Alternatively, use the commands in the "MM04 Communication Protocol Document" to manually enter new configurations.

PRINTING DATA

Once the waveform tables have been edited, the MM04 serves as a pass-through for serial printing data. Three bits per nozzle are loaded at a time and relayed to the print head's internal registers. The MM04 provides a check to make certain that fire pulses are timed appropriately. MM04 handles the writing of matrix data and reading EEPROM data of the print head.

EXTERNAL EQUIPMENT

MM04 requires a 5V supply into pin 33 and a 20-34V supply into pins 37, 39, and 41 of the edge card connector. See Analog Specifications for current requirements of these supplies.

On-board DC-DC converters use the above two supplies to generate auxiliary voltages for other components, each indicated with LEDs. See below table for description of each. This information is provided for troubleshooting purposes and is not necessary for the average user.

Voltage Indicated by LED	LED Designation	Description	Power Source	Value
$+V_S$	LD8	High Current Supply for Power Amplifier. Connects to $+V_S$ of MP204 (All Channels). VCOM will not exceed $+V_S$.	$+V_S$	20-34V
$+V_B$	LD1	Boosted Voltage for Driving Analog Portion Closer to High-Side Saturation. Connects to $+V_B$ of MP204 (All Channels). Also connects to Vh of the print head.	$+V_S$	$+V_S$ +6V
$-V_B$	LD3	Negative Voltage for Driving Analog Portion Closer to Low-Side Saturation. Connects to $-V_B$ of MP204 (All Channels).	V_{CC}	-5V
V_{CC}	LD7	5V Supply for Digital Components.	V_{CC}	5V
V_{DD}	LD2	3.3V Supply for Digital Components.	V_{CC}	3.3V

INDICATION LEDS

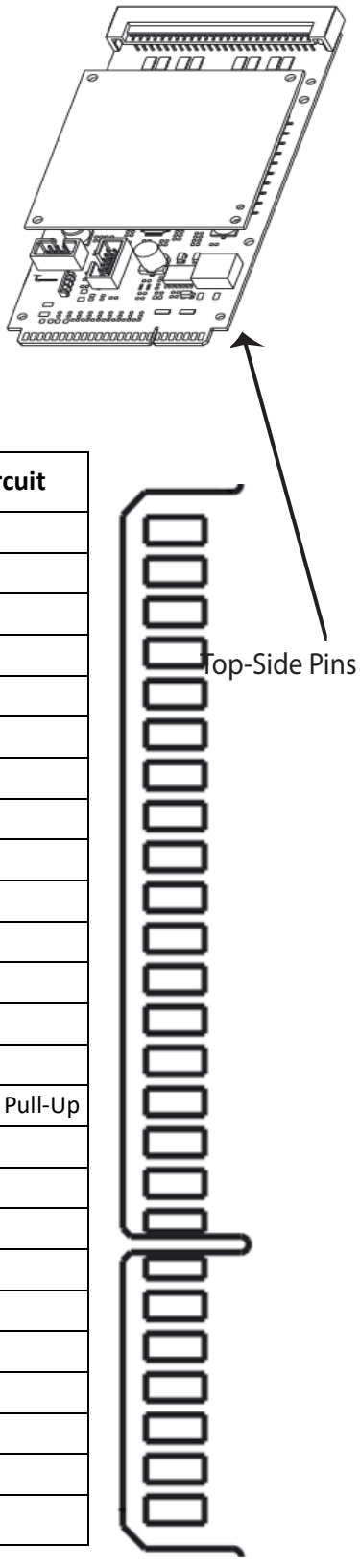
In addition to the Voltage status LEDs listed above, the following LEDs indicate system status.

LED	LED Designation	Description
WAVE	LD9	Indicates a fault condition. See “Fault Indication” section for details.
TXD	LD10	Reserved for future use.
RXD	LD11	Reserved for future use.
ONLN	LD6	When illuminated, all four channels are ready for $\overline{\text{PRINT}}$ signal. When not illuminated, this could indicate an invalid waveform.

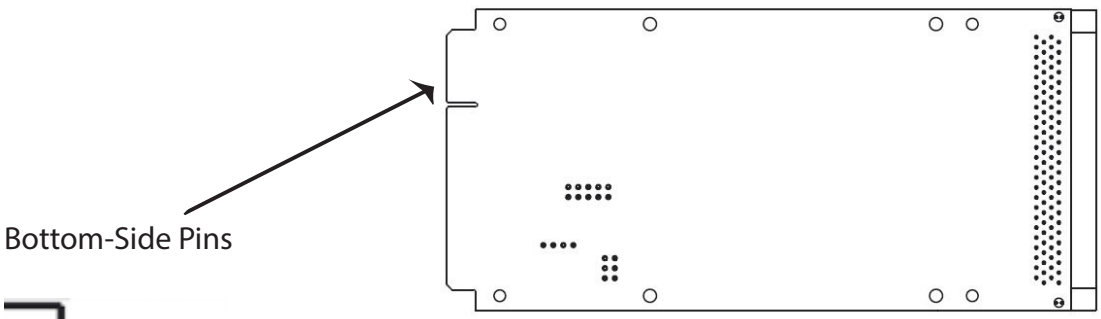
PIN OUT

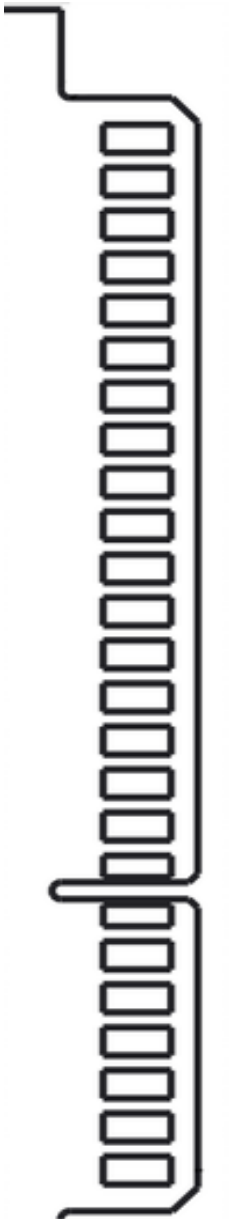
CARD EDGE CONNECTOR (INPUT)

Connector type: Card edge connector, 50-pins (mates with: TE 5530843-5)



Pin	Signal	I/O	Description	Equivalent Circuit
1	DGND	---	Digital Ground	GND
3	SDIN1_1	Input	Shift register bit 1 row 1	High-Z input
5	SCKIN_1	Input	Shift clock row 1	High-Z input
7	SDIN0_2	Input	Shift register bit 0 row 2	High-Z input
9	SDIN2_2	Input	Shift register bit 2 row 2	High-Z input
11	$\overline{\text{PRINT\_2}}$	Input	Print trigger row 2	12kΩ pull-up input
13	SDIN1_3	Input	Shift register bit 1 row 3	High-Z input
15	SCKIN_3	Input	Shift clock row 3	High-Z input
17	SDIN0_4	Input	Shift register bit 0 row 4	High-Z input
19	SDIN2_4	Input	Shift register bit 2 row 4	High-Z input
21	$\overline{\text{PRINT\_4}}$	Input	Print trigger row 4	12kΩ pull-up input
23	$\overline{\text{BUSY\_1}}$	Output	Row 1 is busy	Push-Pull
25	$\overline{\text{BUSY\_3}}$	Output	Row 3 is busy	Push-Pull
27	$\overline{\text{RESET}}$	Input	Module RESET	40kΩ Pull-Up
29	SDA	I/O	I2C Data	Push-Pull w/ 4.7kΩ Pull-Up
31	RXD	Input	UART Receive	10k Pull-Up
33	V_{CC}	---	+5V supply (digital components)	Supply
35	NC	---	Not connected	-
37	$+V_S$	---	High current supply	Supply
39	$+V_S$	---	High current supply	Supply
41	$+V_S$	---	High current supply	Supply
43	HS-GND	---	GND for print head heat sink	GND
45	THERMA	Output	Thermistor (pass-through to print head)	Wire
47	HEATER0+	---	Heater + (pass-through to print head)	Wire
49	HEATER1+	---	Heater + (pass-through to print head)	Wire

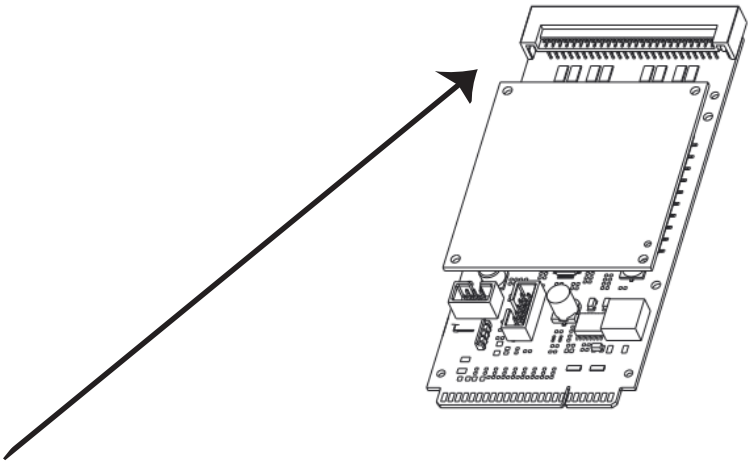




Pin	Signal	I/O	Description	Equivalent Circuit
2	SDIN0_1	Input	Shift register bit 0 row 1	High-Z Input
4	SDIN2_1	Input	Shift register bit 2 row 1	High-Z Input
6	$\overline{\text{PRINT\_1}}$	Input	Print trigger row 1	12kΩ Pull-Up Input
8	SDIN1_2	Input	Shift register bit 1 row 2	High-Z Input
10	SCKIN_2	Input	Shift clock row 2	High-Z Input
12	SDIN0_3	Input	Shift register bit 0 row 3	High-Z Input
14	SDIN2_3	Input	Shift register bit 2 row 3	High-Z Input
16	$\overline{\text{PRINT\_3}}$	Input	Print trigger row 3	12kΩ Pull-Up Input
18	SDIN1_4	Input	Shift register bit 1 row 4	High-Z Input
20	SCKIN_4	Input	Shift clock row 4	High-Z Input
22	DGND	Input	Digital Ground	GND
24	$\overline{\text{BUSY\_2}}$	Output	Row 2 is busy	Push-Pull
26	$\overline{\text{BUSY\_4}}$	Output	Row 4 is busy	Push-Pull
28	$\overline{\text{FAULT}}$	Output	Module Error	Open-Drain
30	SCL	I/O	I2C Clock	Push-Pull w/ 4.7kΩ Pull Up
32	TXD	Input	UART Transmit	Push-Pull
34	DGND	---	Ground for digital components	GND
36	NC	---	Not Connected	-
38	PGND	---	Power ground	GND
40	PGND	----	Power ground	GND
42	PGND	---	Power ground	GND
44	HS_GND	---	GND for print head heat sink	GND
46	THERMB	Output	Thermistor (pass-through to print head)	Wire
48	HEATER0-	---	Heater - (pass-through to print head)	Wire
50	HEATER1-	---	Heater - (pass-through to print head)	Wire

Note: Grounds are connected on the MM04. Do not connect DGND, PGND, or HS-GND elsewhere. This is to avoid analog ground loops, which negatively impact signal quality.

PRINT HEAD CONNECTOR (OUTPUT)



Connector type: TX25 Plug type, 100-pin
(Example TX25-100P-6ST-H1E, JAE)
(Pin table provided for reference only)

Pin No	Signal	Name	Pin No	Signal	Name
1	GND	Digital ground	51	GND	Digital ground
2	COM_1	VCOM_1 return	52	COM_1	VCOM_1 return
3	VCOM_1	Piezo drive voltage row 1	53	VCOM_1	Piezo drive voltage row 1
4	VCOM_1	Piezo drive voltage row 1	54	VCOM_1	Piezo drive voltage row 1
5	COM_1	VCOM_1 return	55	COM_1	VCOM_1 return
6	$\overline{\text{MCLK\_1}}$	Matrix clock row 1	56	$\overline{\text{ML\_1}}$	Matrix latch row 1
7	MD_1	Matrix data row 1	57	SDOUT0_1	Shift register bit 0 row 1
8	SDOUT1_1	Shift register bit 1 row 1	58	SDOUT2_1	Shift register bit 2 row 1
9	$\overline{\text{SL\_1}}$	Latch signal row 1	59	SCKOUT_1	Shift clock row 1
10	TH+	Thermistor (+)	60	TH-	Thermistor (-)
11	COM_2	VCOM_2 return	61	COM_2	VCOM_2 return
12	VCOM_2	Piezo drive voltage row 2	62	VCOM_2	Piezo drive voltage row 2
13	VCOM_2	Piezo drive voltage row 2	63	VCOM_2	Piezo drive voltage row 2
14	COM_2	VCOM_2 return	64	COM_2	VCOM_2 return
15	MCLK_2	Matrix clock row 2	65	$\overline{\text{ML\_2}}$	Matrix latch row 2
16	MD_2	Matrix data row 2	66	SDOUT0_2	Shift register bit 0 row 2
17	SDOUT1_2	Shift register bit 1 row 2	67	SDOUT2_2	Shift register bit 2 row 2
18	$\overline{\text{SL\_2}}$	Latch signal row 2	68	SCKOUT_2	Shift clock row 2
19	V_{DD}	3.3V logic supply	69	V_{DD}	3.3V logic supply
20	VH	High voltage logic supply	70	VH	High voltage logic supply
21	NC	-	71	HEATER1+	Heater positive supply
22	HEATER0+	Heater positive supply	72	HEATER1+	Heater positive supply

23	HEATER0+	Heater positive supply	73	HEATER1-	Heater negative supply
24	HEATER0-	Heater negative supply	74	HEATER1-	Heater negative supply
25	HEATER0-	Heater negative supply	75	NC	-
26	HS-GND1	Heat sink ground	76	HS-GND1	Heat sink ground
27	EEP_A1	EEPROM address A1	77	EEP_A2	EEPROM address A2
28	EEP_SDA	EEPROM I2C data	78	EEP_SCL	EEPROM I2C serial clock
29	EEP_WP	EEPROM write protect	79	HS-GND2	Heat sink ground
30	HS-GND2	Heat sink ground	80	NC	-
31	VH	High voltage logic supply	81	VH	High voltage logic supply
32	V_{DD}	3.3V logic supply	82	V_{DD}	3.3V logic supply
33	SCKOUT_3	Shift clock row 3	83	$\overline{SL\_3}$	Latch signal row 3
34	SDOUT2_3	Shift register bit 2 row 3	84	SDOUT1_3	Shift register bit 1 row 3
35	SDOUT0_3	Shift register bit 0 row 3	85	MD_3	Matrix Data row 3
36	$\overline{ML\_3}$	Matrix latch row 3	86	MCLK_3	Matrix Clock row 3
37	COM_3	VCOM_3 return	87	COM_3	VCOM_3 return
38	VCOM_3	Piezo drive voltage row 3	88	VCOM_3	Piezo drive voltage row 3
39	VCOM_3	Piezo drive voltage row 3	89	VCOM_3	Piezo drive voltage row 3
40	COM_3	VCOM_3 return	90	COM_3	VCOM_3 return
41	NC	-	91	NC	-
42	SCKOUT_4	Shift clock row 4	92	$\overline{SL\_4}$	Latch signal row 4
43	SDOUT2_4	Shift register bit 2 row 4	93	SDOUT1_4	Shift register bit 1 row 4
44	SDOUT0_4	Shift register bit 0 row 4	94	MD_4	Matrix data row 4
45	$\overline{ML\_4}$	Matrix latch row 4	95	MCLK_4	Matrix clock row 4
46	COM_4	VCOM_4	96	COM_4	VCOM_4 Return
47	VCOM_4	Piezo drive voltage row 4	97	VCOM_4	Piezo drive voltage row 4
48	VCOM_4	Piezo drive voltage row 4	98	VCOM_4	Piezo drive voltage row 4
49	COM_4	VCOM_4 return	99	COM_4	VCOM_4 return
50	GND	Digital ground	100	GND	Digital ground

DIGITAL SPECIFICATIONS

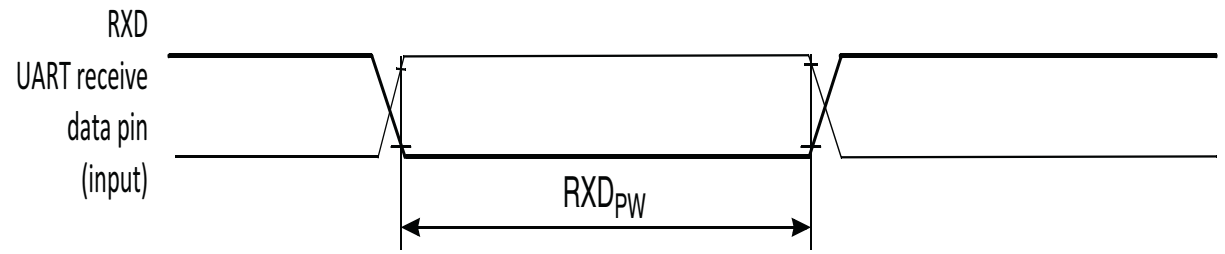
PRINT CONTROL SIGNALS

Parameter	Test Conditions/ Notes	Min	Typ	Max	Units
Control Output Low Level Voltage, V_{OL}				0.9	V
Control Output High Level Voltage, V_{OH}		2.5			V
Control Input Low Level Voltage, V_{IL}		-0.3		0.8	V
Control Input High Level Voltage, V_{IH}		2.5		3.6	V

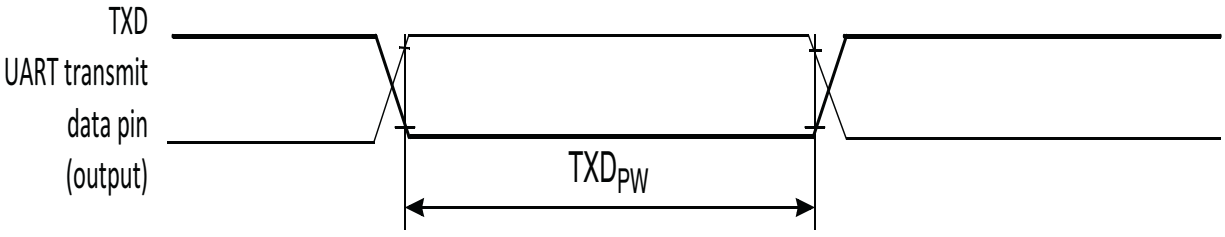
ASYNCHRONOUS SERIAL COMMUNICATION INTERFACE (UART)

Parameter	Test Conditions/ Notes	Min	Typ	Max	Units
Baud Rate			9600		bit/s
RXD Pulse Width	RXD_{PW}	100.52		108.33	µs
TXD Pulse Width	TXD_{PW}	100.52		108.33	µs
RXD Data Setup Time	T_{SETUP}	6.51			µs
RXD Data Hold Time	T_{HOLD}	6.51			µs

Figure 2: UART Timing Graphics

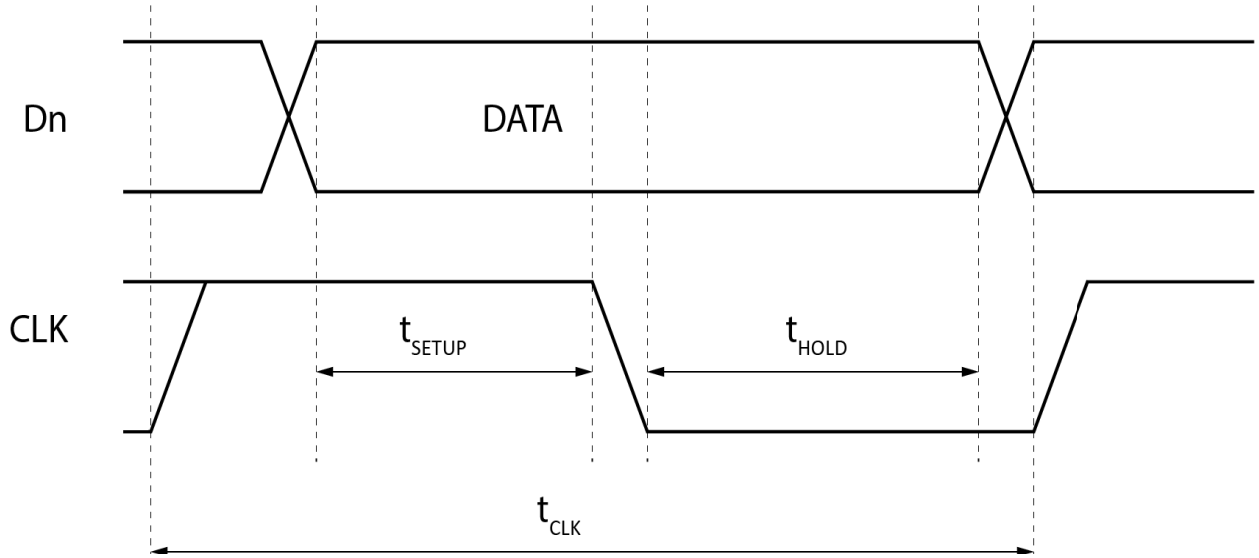


UART RXD pulse width



UART TXD pulse width

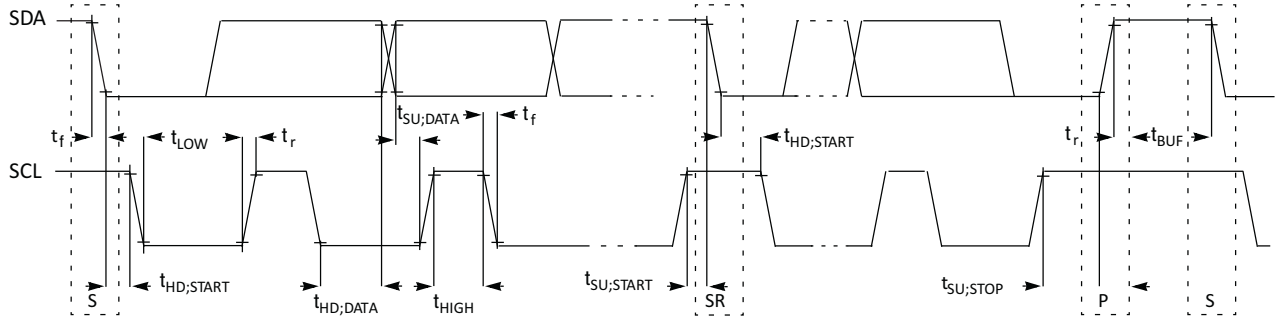
Figure 3: UART Setup and Hold Times



INTER-INTEGRATED CIRCUIT INTERFACE (I2C)

Parameter	Symbol	Min	Typ	Max	Units
SCL Clock Frequency		0		100	kHz
Low period of the SCL clock	t_{LOW}	4.7			µs
High period of the SCL clock	t_{HIGH}	4			µs
Setup time for repeat START condition	$t_{SU;START}$	4.7			µs
Data hold time for I2C bus devices	$t_{HD;DATA}$			3.45	µs
Data setup time	$t_{SU;DATA}$	0.25			µs
Rise time of SDA and SCL signals	t_r			1.0	µs
Fall time of SDA and SCL signals	t_f			0.3	µs
Setup time for STOP condition	$t_{SU;STOP}$	4			µs
Bus free time between STOP and START	t_{BUF}	4.7			µs

Figure 4: I2C Timing



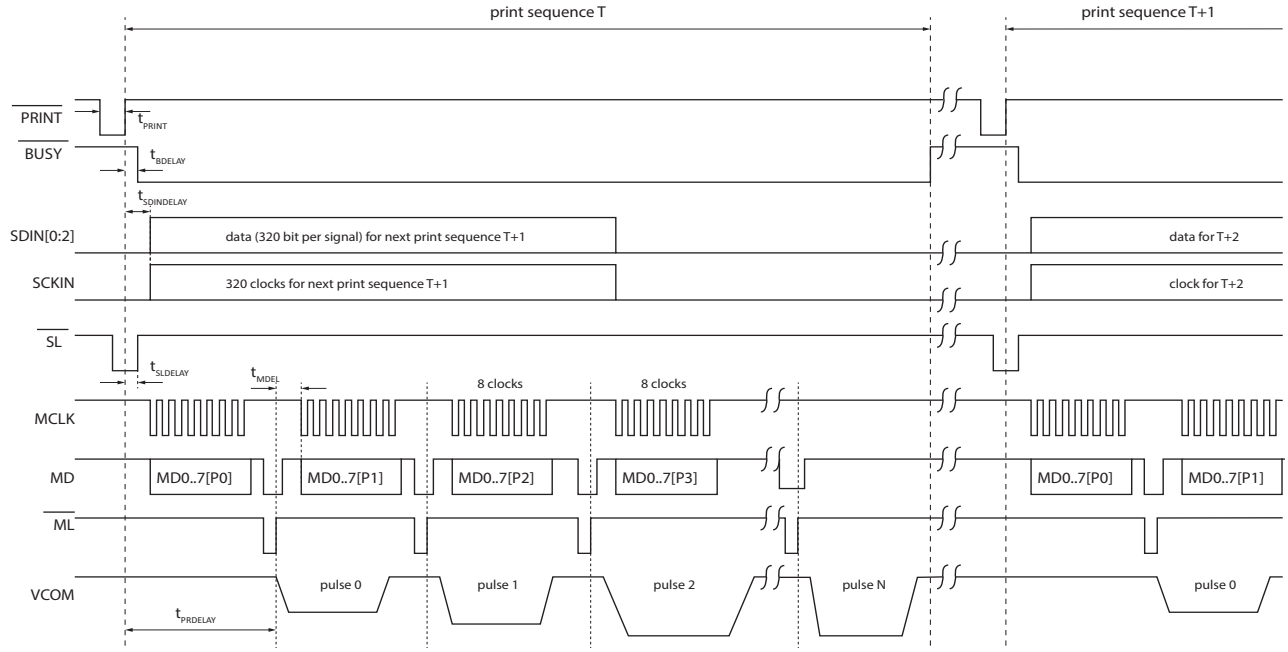
Timing definition I2C bus

Note: Default I2C address is 0x50

PRINT HEAD SIGNAL TIMING

The signals for each of the 4 nozzle rows are as follows:

Figure 5: Waveform Timing Diagram



Parameter	Symbol	Min	Typ	Max	Units
Print Pulse Width	t_{PRINT}	50			ns
$\overline{\text{PRINT}}$ ↑ to $\overline{\text{BUSY}}$ ↓ Delay	t_{BDELAY}		37.5	100	ns
$\overline{\text{PRINT}}$ ↑ to VCOM Output Delay	$t_{SLDELAY}$		50	100	ns
$\overline{\text{PRINT}}$ ↑ to Next Data Input Delay[1]	$t_{SDINDELAY}$	200			ns
$\overline{\text{ML}}$ ↑ to Next Matrix Shift Delay[1]	t_{MDELAY}	20		200	ns
$\overline{\text{PRINT}}$ ↑ to MCLK ↓	$t_{MCLKDELAY}$		225		ns
MD ↓ to MD ↑	t_{MATRIX}		540		ns
$\overline{\text{PRINT}}$ ↑ to MD ↑	$t_{VCDELAY}$		700		ns
Matrix Data Shift Clock	f_{MCLK}		20		MHz
Maximum Number of Pulses	N			8	
Startup Delay				25	ms

1. See Print Head Specification

Each of the 4 rows operate fully asynchronous, meaning that a row might receive a $\overline{\text{PRINT}}$ trigger at any point in time to start a waveform output

PASS-THROUGHS

The following signals are considered pass-throughs by the MM04:

Signal Name	Input Name	Output Name	Delay	Comments
Serial Data	SDIN[0..2]_X	SDOUT[0..2]_X	1-2 clock cycles	
Serial Clock	SCKIN_X	SCKOUT_X	1-2 clock cycles	
Print Signal	$\overline{\text{PRINT\_X}}$	$\overline{\text{SL\_X}}$	1-2 clock cycles	MM04 checks that no output is active when signal is triggered.
Heater	HEATERX±	HEATERX±	None, wire	
Thermistor	THERM[A..B]	TH[+..-]	None, wire	

LOADING EFFECTS

The following plots show typical VCOM waveforms at 0% load (all nozzles off) and 100% load (all nozzles on). Green= Channel 0, Brown= Channel 1. Baseline Voltage=20V.

Figure 6: 0% Load

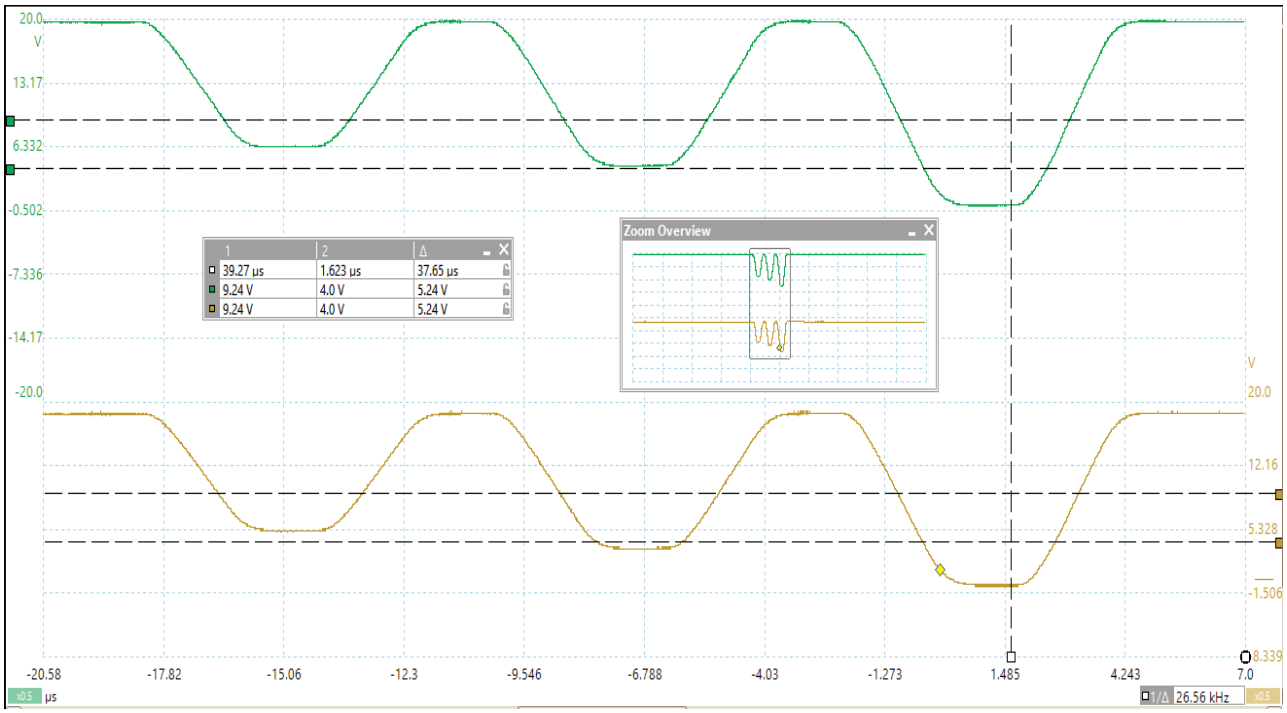
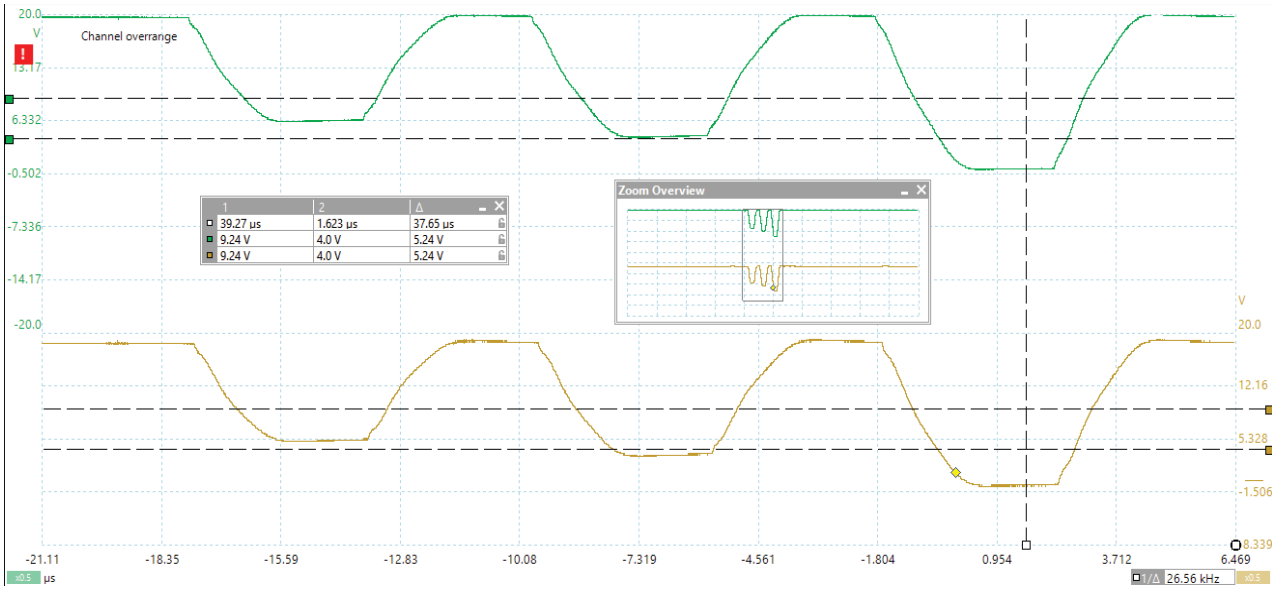


Figure 7: 100% Load



ANALOG SPECIFICATIONS

Unless noted otherwise, the analog output of MM04 has been characterized under the following conditions:

- Temperatures from 0 to 85°C
- $+V_S$ = 30V

OUTPUT (PER AMPLIFIER CHANNEL)

Parameter	Test Conditions	Min	Typ	Max	Units
Voltage Swing to $+V_S$	I_{OUT}= 1.0 A, $+V_B = +V_S$	$+V_S$ - 8		$+V_S$ - 6	V
Voltage Swing to GND	I_{OUT}= -1.0 A, $-V_B$ = PGND-5V[1]	PGND + 0.4		PGND + 1.2	V
Voltage Swing to $+V_S$	I_{OUT}= -1.0 A, $+V_B = +V_S$ + 6V[1]		$+V_S$ + 1		V
Voltage, Output Accuracy[2]	V_{OUT} = 30V			0.1	V
Current, continuous[3]		1.5		SOA	A
Overshoot[2]	Full Temperature range			10	%
Undershoot[2]	Full Temperature range			1	V
Slew Rate	C_{LOAD}= 320nF	15			V/µs
Capacitive Load				320	nF

1. The MP204 Print Head Power Amplifier supplies $+V_B$ and $-V_B$ are generated on board the MM04 by DC-DC switching power supplies. $+V_B = V_{H.}$ (Print Head "High Voltage Logic" supply)
2. Output accuracy, overshoot and undershoot are guaranteed by design.
3. The continuous current is internally limited to approximately 5.6A per channel. Also limited by SOA.

POWER SUPPLY REQUIREMENTS

Parameter		Test Conditions	Min	Typ	Max	Units
Voltage, $+V_S$			20	24	34	V
Output Drive Supply Current, $+I_{S\ peak}$					5.6[1]	A
Voltage, V_{CC}			4.75	5.0	5.25	V
Low Voltage Supply Current, I_{CC}					1	A
Current, Quiescent	$+V_S$ to GND	$+V_S$ = 24V		80		mA
	V_{CC} to GND			140		mA
Current Consumption, Operation	$+V_S$ to GND	PRF = 33 kHz, C_{LOAD} = 320nF		2		A
	V_{CC} to GND			200		mA

1. The $+V_S$ supply must provide all piezo drive current for all four channels of the MM04. Therefore, peak current may be as high as (4 channels) x (5.6 A per channel) = 22.4A. However, power supply bypass capacitors of 22µF exist on each channel, eliminating the need for a supply capable of the peak current. In typical applications, a single $+V_S$ power supply with 3A capability is sufficient.

SAFE OPERATING AREA

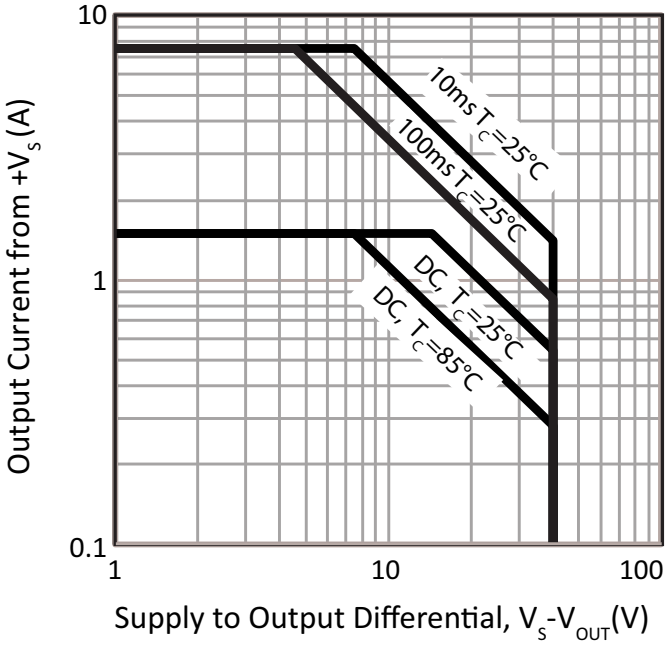
Refers to MP204 Fire Pulse Amplifier Board

Parameter	Test Conditions	Min	Typ	Max	Units
Resistance, AC, junction to case[1]	Full temp range, F > 60 Hz		4.5		°C/W
Resistance, DC, junction to case	Full temp range, F < 60 Hz		5.8		°C/W
Resistance, junction to air	Full temp range		14.5		°C/W
Temperature Range, case	Meets full range specifications	0		85	°C

1. Rating applies if the output current alternates between both output transistors at a rate faster than 60 Hz.

SAFE OPERATING AREA

Figure 8: SOA



BEFORE APPLYING POWER

POWER SUPPLY SEQUENCING

For reliable operation, it is suggested that the power supplies be turned on and off in the following sequence;

Power on sequence: V_{CC}, $+V_S$

Power off sequence: $+V_S$, V_{CC}

HEATSINKING

The Insulated Metal Substrate (IMS, aluminum backplate) board provides a very low thermal resistance path for the heat generated by the high power of the fire pulse amplifier. This IMS board must be attached to a heat sink of adequate size for heat dissipation and reliable operation. Mounting holes for mounting the IMS board to the heat sink are located in each corner of the IMS board. typically, 1/2" standoffs are used to fasten the IMS board to the heat sink, and complimentary screws affix the MM04 digital portion to the standoffs (through access holes coincident to the IMS board mounting holes).

The analog power amplifier must have thermally conductive media between the IMS board and the heat sink. Thermal grease is the most common media. Apply a thin and even layer of thermally conductive grease across the entire mating surface of the amplifier (aluminum backplate). Avoid separation of the liquid from the solids in the grease. Too high a percentage of either can result in amplifier destruction due to thermal or mechanical stress. Stirring the thermal grease before application is recommended.

Tighten fasteners in a step-wise, diagonal fashion to avoid cracking the substrate. 4-7 in-lbs (0.45-0.79 Nm) of torque is recommended. Torquing above 7 in-lbs provides no thermal benefit and will likely crack the substrate. The IMS board must sit flush to the heat sink with no gaps between the IMS board and heat sink.

The internal power dissipation of the MM04 fire pulse amplifier is limited to 20W per channel at a case temperature of 25°C. The IMS board must be mounted to a heat sink with low enough thermal resistance to ambient to maintain the case temperature at a safe level. For example, with ambient temperature of 25°C and average internal power dissipation of 55W the maximum allowable case temperature is 80°C. A heat sink with a thermal resistance rating of 1°C/W is needed.

Internal Power Dissipation, P_D = 55W
Allowable Case Temperature, T_C = 80°C
Ambient Temperature, T_A = 25°C

Heat Sink Thermal Resistance, $R_{TH} = (T_C - T_A)/ P_D = (80°C - 25°C)/55W = 1°C/W$

Refer to Apex Application Note library for more information and examples on calculating power dissipation. Heat sink thermal resistance can be improved by using active cooling such as forced air or liquid cooling. The average internal power dissipation can be reduced by decreasing the duty cycle of the fire pulse wave form (lower frequency).

TEMPERATURE PROTECTION

MM04 monitors the temperature of its fire pulse amplifier components, and will automatically go offline when the temperature of any channel driver exceeds the programmed range. See MM04 Communication Manual for more information on setting the temperature threshold and hysteresis values.

Parameter	Test Conditions	Min	Typ	Max	Units
Temperature Accuracy	T_C = 0°C to 85°C			±2	°C

FAULT INDICATION

The $\overline{\text{FAULT}}$ pin (pin 28 of the edge card connector) indicates any errors that would prevent the MM04 from going online or remaining online. This pin is an open drain, so a pull-up resistor to 3.3V is required to monitor the fault signal.

At power-up of the MM04, $\overline{\text{FAULT}}$ is active low. Upon successful transition to ONLINE status, $\overline{\text{FAULT}}$ will transition to high.

$\overline{\text{FAULT}}$ will transition to low or remain low if any of the following are true:

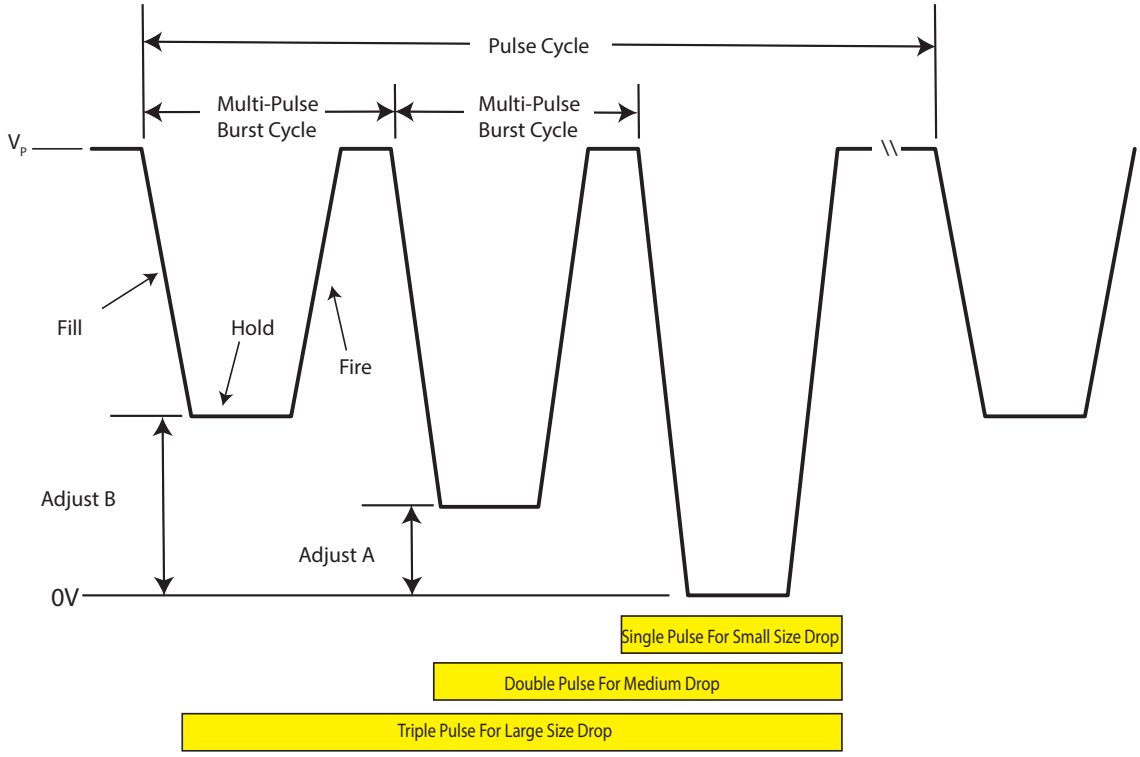
1. +VS supply is outside of programmed range.
2. +VB supply is outside of programmed range.
3. V_{CC} supply is outside of programmed range.
4. Channel A/B temperature is outside of programmed range.
5. Channel C/D temperature is outside of programmed range.
6. An invalid or blank waveform is uploaded to any channel of MM04.
7. The module is offline.

DRIVE PULSE GUIDELINES AND EXAMPLES

The following diagrams show typical pulse drive options for the Ricoh GEN5 print head. These are given for reference. For more information, see the MM04 Manager GUI User's Guide and/or the Ricoh GEN5 print head Product Specification.

DRIVE PULSE DESIGN GUIDELINE

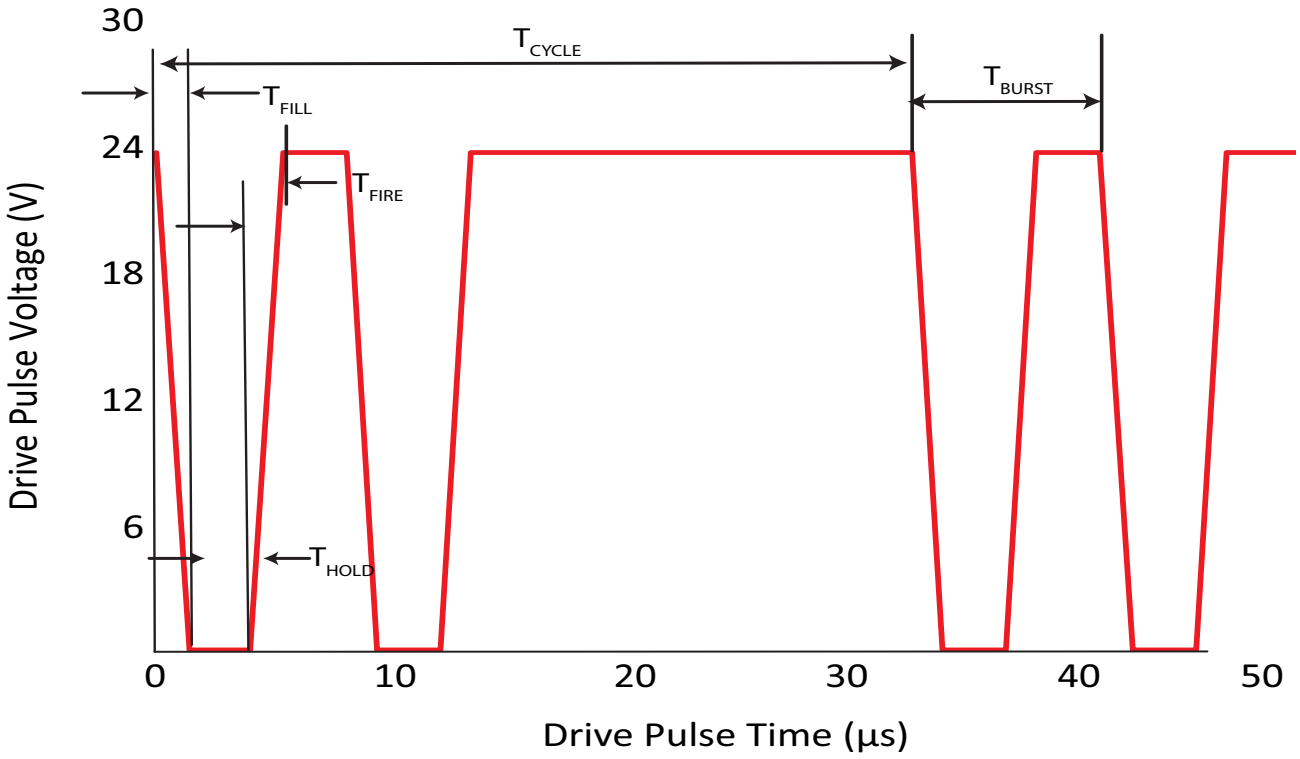
Figure 9: Drive Pulse Design Guideline



Fall Time (Fall Time)	2.5µs (fixed)
Hold Time	~ 5.5µs
Fire Time (Rise Time)	2.5µs (fixed)
Multi-Pulse Burst Cycle Time	12 - 16µs
Adjust "A" Voltage	5% - 15%
Adjust "B" Voltage	10% - 30%
VP Voltage	≤ 25V
Fire Cycle Time	≥50µs

Example Waveform:

Figure 10: Example Waveform



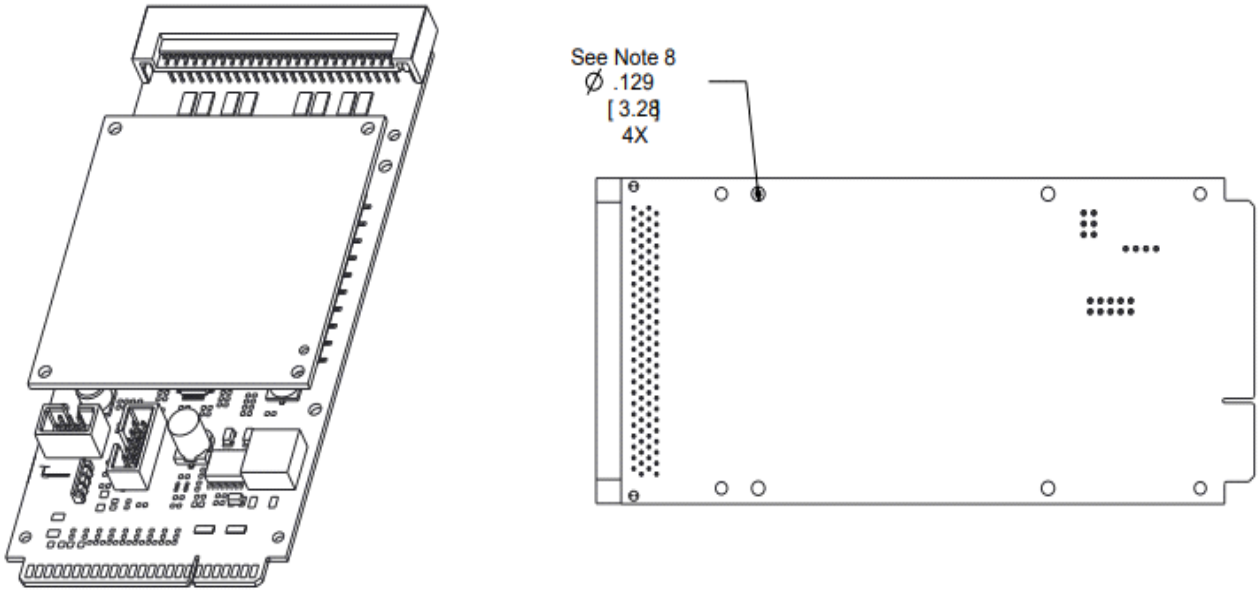
Fill Time(T_{FILL})	2.0µs
Hold Time(T_{HOLD})	2.0µs
Fire Time (T_{FIRE})	2.0µs
Burst Cycle Time (T_{BURST})	8.0µs
Fire Cycle Time (T_{CYCLE})	33µs (30 kHz)
Voltage Range	24 V_{PP} (range 19V -> 34V, depending on system considerations)
Load	0-320nF

PACKAGE MECHANICAL DRAWINGS

PACKAGE OPTIONS

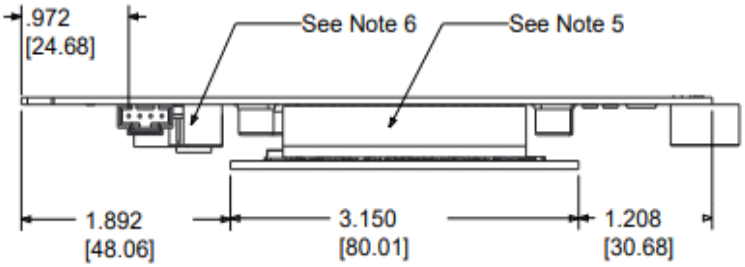
Part Number	Apex Package Style	Description
MM04	ND	Mixed Signal Print Head Driver, 50P, 100P

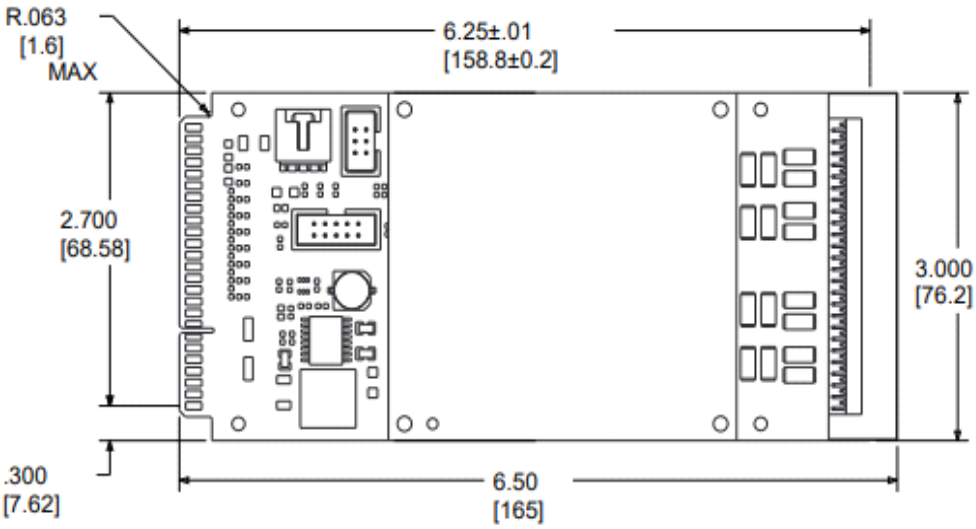
PACKAGE STYLE ND

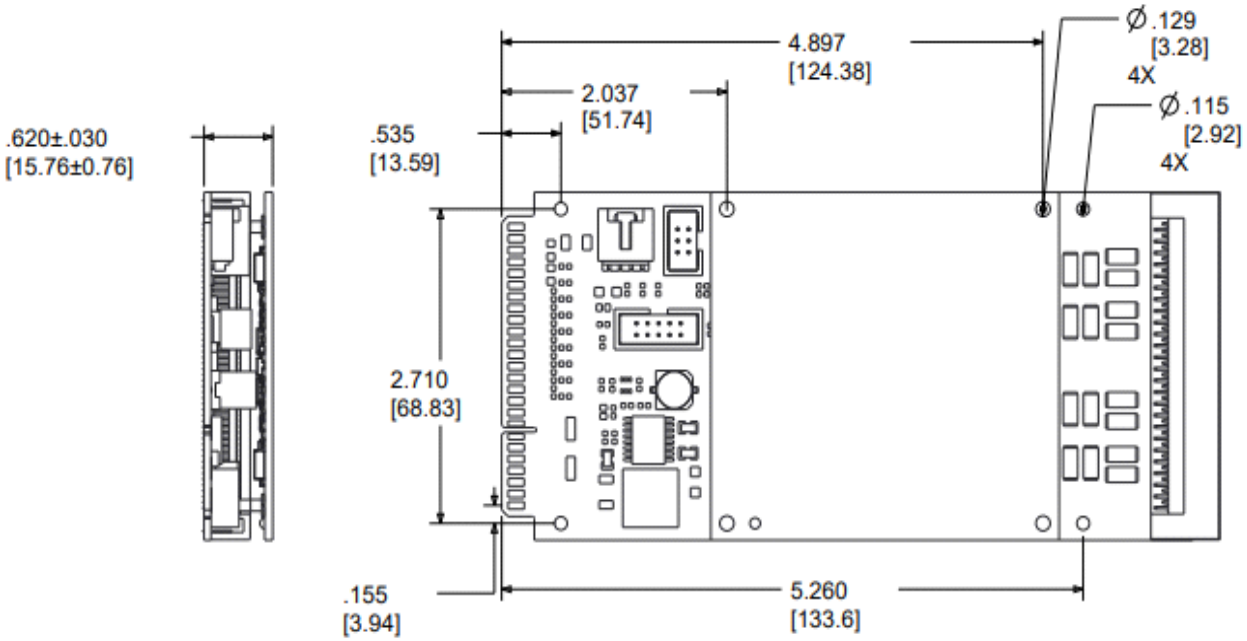


NOTES:

1. Dimensions are in inches [mm]
2. Recommended mating edge connector or equivalent:
   50-position TE Connectivity p/n 5532600-2
   JAE TX24-100R-LT-H1E (Print Head)
3. Material:
   Digital Unit -.062 [1.57] thick FR-4, 2 oz. Cu conductors.
   Analog Unit- .072 [1.83] thick, 2 oz. Cu conductors over 600V dielectric over Al substrate.
4. Hard gold plating on edge connector contacts.
5. Not recommended that mating connectors between digital and analog units be used as mechanical support.
6. When designing or choosing a heat sink, allow adequate space for components on the digital side.
7. Use #4 or equivalent screws (M3) for mounting analog unit to heat sink.
8. Four holes in digital unit, used to mount digital board to standoffs, are .129in [3.28mm].
9. Package Weight: 110 grams.
10. To mount MM04 to a heatsink or cooling hardware, unplug the analog portion of MM04 from the digital board. Attach the analog portion to the cooling hardware using (quantity 4) #4-40 male-female 1/2 inch standoffs. Then, reattach the digital portion to the analog board, and secure with (quantity 4) #4-40 screws into the holes described in (8).


.972
[24.68]
See Note 6
See Note 5
1.892
[48.06]
3.150
[80.01]
1.208
[30.68]


R.063
[1.6]
MAX
6.25±.01
[158.8±0.2]
2.700
[68.58]
3.000
[76.2]
.300
[7.62]
6.50
[165]


.620±.030
[15.76±0.76]
4.897
[124.38]
2.037
[51.74]
.535
[13.59]
Ø.129
[3.28]
4X
Ø.115
[2.92]
4X
2.710
[68.83]
.155
[3.94]
5.260
[133.6]