RC7352

Parametric Measurement Unit

Features

- Force voltage/measure current and force current measure voltage functions
- Forced voltage range (-5V to +15V)
- Four programmable measured current ranges:
  Range A = ±20μA max
  Range B = ±200μA max
  Range C = ±1.0mA max
  Range D = ±40mA max
- High resolution current force/measure ±0.05% = 2 bits
- Internal control circuitry for selecting ranges
- High accuracy: 12 bit linearity and 0.5% gain error
- High current range D current limit protection set externally by the value of resistor R_{DIL}
- Measurement output voltage can be disabled
- Forced current ranges:
  Range A = ±20μA max
  Range B = ±200μA max
  Range C = ±1.0mA max
  Range D = ±40mA max
- Measured voltage range: -5V to +15V
- High resolution voltage measurement (±0.05%) and accuracy: (±10mV max. offset) and 0.5% gain error
- Internal current limit for ranges (A, B, & C)

Applications

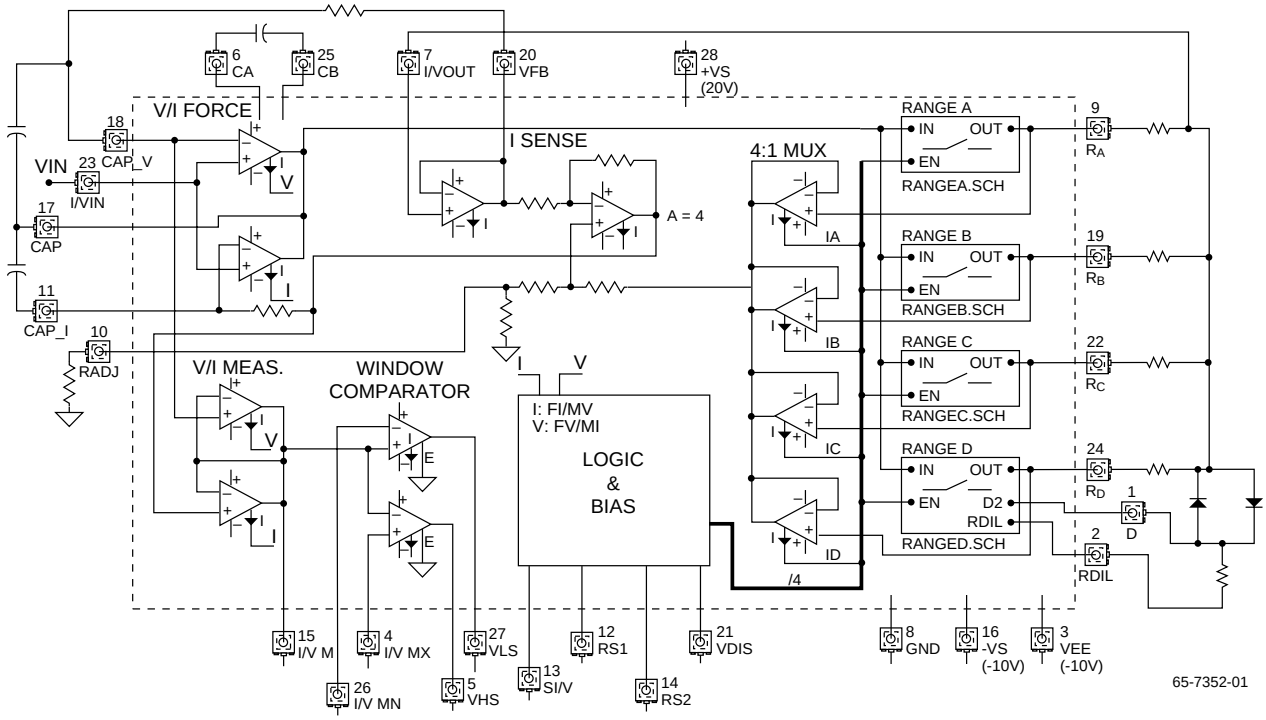
- ATE pin electronics measurements
- Instrumentation, meters
- Programmable voltage or current supply

Description

The RC7352 is a “Per Pin” Parametric Measurement Unit (PMU) that can force voltage and measure current or force current and measure voltage. The RC7352 forces voltages from +15V to -5V when $+V_S$ is 20V and $–V_S$ is -10V, or currents up to ±40mA. All logic inputs for the RC7352 are TTL compatible, while the open collector logic outputs are TTL/CMOS compatible.

Setting the SI/V (Select I/V) pin low puts the RC7352 in the force voltage and measure current mode. The resulting output voltage at the DUT matches the input applied to the

Block Diagram



I/VIN pin (please refer to block diagram). The I/VM pin provides a voltage proportional to the DUT current. V(I/VM) = (4 x R x I(DUT)), where R is the external range resistor (0.05% tolerance) and I(DUT) is the current supplied to the load. The resistors in the application circuit were chosen using this formula R range = (2V/Imax), for Range A this is RA = 2/20 μA or 100K.

When SI/V is high the RC7352 will force current and measure voltage. The range select pins RS1 and RS2 control the maximum output current (see Table 1), while magnitude of the forced current is given by the expresion

I(DUT) = V(I/VIN)/(4 x R)

where R is the range resistor. In the FI/MV mode the voltage at the I/VM pin equals the device voltage. The I/VM pin can be connected to an A/D convertor to monitor the current or voltage at the load device.

The RC7352 also has a window comparator that can provide upper or lower limit fail information. I/Vmx and I/Vmn are voltage inputs for the upper and lower limits respectively. You must use the formulas listed above to calculate current limits for each range while voltage limits are 1:1. Their corresponding outputs, VHF (V high fail) and VLF (V low fail) can be used individually or “Wire ORed” to obtain a composite signal. Additionally the VDIS pin can be set high to disable the window comparator and its I/O lines. Although this reduces overall power consumption, it also disables the I/VM output.

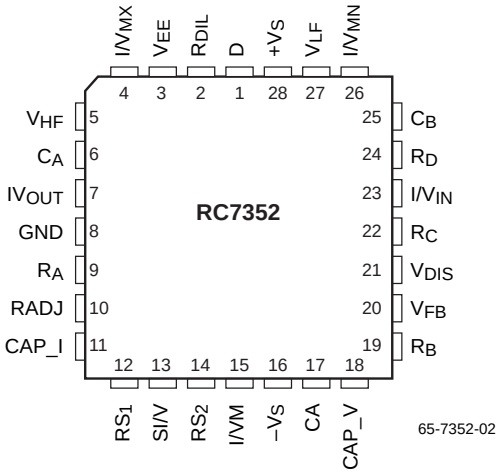
Table 1. Maximum Output Current on Pin Select

SI/V	RS2	RS1	Mode
0	0	0	FV/MI Range A, Imax = ±20 μA
0	0	1	FV/MI Range B, Imax = ±200 μA
0	1	1	FV/MI Range C, Imax = ±1.0 mA
0	1	0	FV/MI Range D, Imax = ±40 mA
1	0	0	FI/MV Range A, Imax = ±20 μA
1	0	1	FI/MV Range B, Imax = ±200 μA
1	1	1	FI/MV Range C, Imax = ±1.0 mA
1	1	0	FI/MV Range D, Imax = ±40 mA

Notes:

1. FV/MI = Force Voltage Measure Current.
2. FI/MV = Force Current Measure Voltage.
3. $+V_S - 5 \geq V_{OUT} \geq -V_S + 5$

Pin Assignments



Pin Description

Pin Name	Pin Number	Pin Description
$+V_S$	28	$+V_S$ should be bypassed to ground with a 10.0 μF tantalium capacitor placed as close to the pin as possible.
$-V_S$	16	$-V_S$ should be bypassed to ground with a 10.0 μF tantalium capacitor placed as close to the pins as possible.
V_{EE}	3	V_{EE} is the negative supply for range D. This pin should be bypassed with a 0.1 μF ceramic capacitor to ground.
GND	8	This pin should be connected to the printed circuit board's ground plane.
I/V_{IN}	23	Input reference voltage for V_{OUT} or I_{OUT}. In the force voltage measure current mode (FV/MI) $V(I/V_{OUT}) = V(I/V_{IN})$ and $V(I/VM) = 4 \times I_{OUT} \times R$ Where I_{OUT} is the device output current and R is the range resistor. In the Force Current/Measure Voltage Mode $I_{OUT} = \frac{V(I/VIN)}{4 \times R}$ $V(I/VM) = V(I/V_{OUT})$
I/V_{OUT}	7	The Load or Device under test is connected to I/V_{OUT}. The current to the load is supplied via the appropriate range resistor with I/V_{OUT} serving as the voltage feedback point for the PMUs internal instrumentation amplifier.
SI/V	13	A TTL/CMOS signal applied to this pin selects either Force Voltage/Measure Current or Force Current/Measure Voltage mode. A TTL/CMOS low level will select Force Voltage/Measure Current function. A TTL/CMOS high level selects Force Current/ Measure Voltage mode.
R_A	9	Resistor R_A should be placed between R_A and I/V_{OUT}. R_A tolerance should be better than +0.05% to improve gain error. Maximum current for range A is shown in the equation below. $I_A = \frac{\pm 2V}{R_A}$ The ±2 volts represents the maximum voltage V_A across R_A. For Range A, I_A should not exceed ±20 μA, i.e., R_A should be higher than or equal to 100 kΩ. A metal film resistor should be used to reduce inherent resistor noise (schott and pop corn noise) and improve resolution. For maximum stability, a 300 pF capacitor should be connected across R_A.
R_B	19	For Range B, I_B should not exceed ±200 μA, i.e., R_B should be higher than or equal to 10 kΩ with ±0.05% tolerance. For maximum stability a 1,000 pF capacitor should be connected across R_B.
R_C	22	For Range C, I_C should not exceed ±1 mA, i.e., R_C should be higher than or equal to 2 kΩ with ±0.05% tolerance.
R_D	24	For Range D, I_D should not exceed ±40 mA, i.e., R_D should be higher than or equal to 50 Ω with ±0.05% tolerance.
D	1	Two diodes must be connected between D & R_D as shown in the block diagram.
C_A, C_B	6, 25	A 30pF capacitor placed between these pins will improve stability.
R_{DIL}	2	Range D output for current limiting. An external resistor is connected between RDIL and D to limit current to a value $I_{LIM} = 0.8V/R_{LM}$.

Pin Description (continued)

Pin Name	Pin Number	Pin Description
R_{S1}, R_{S2}	12, 14	R_{S1} and R_{S2} are TTL or CMOS compatible. The truth table below shows the range selection table. R_{S1} R_{S2} Range Selected L L A L H B H H C H L D
I/V_{MX}, I/V_{MN}	4, 26	The voltage applied to pin 4 sets the upper current or voltage limit for the measurement at pin 15 I/VM. To set the desired limit for current measurement a voltage equaling (4 x I_L x R) must be applied on this pin. R is the external resistor of the selected range (A, B, C, or D). For voltage measurement the voltage applied to this pin is the limit.
V_{HF}	5	V_{HF}, High Fail, is an open collector output that requires a pull-up to the logic supply. If the voltage at pin 15, I/VM, is greater than the threshold voltage at pin 4, I/V_{MX}, V_{HF} will become a logic low. The open collector structure makes wire-ORing of multiple PMU's possible. Connect a 3,000 pF capacitor to GND to minimize oscillation at the cross-over point.
V_{LF}	29	V_{LF} mirror V_{HF} for the lower threshold I/V_{MN}. Connect a 3,000 pF capacitor to GND to minimize oscillation at the cross over point.
V_{DIS}	21	When V_{DIS} is tied to ground output I/VM, V_{HF} and V_{LF} are enabled. If V_{DIS} is open V_{HF} and V_{LF} will require external pullups to maintain a logic high. And I/VM will be in a high impedance state.
I/VM	15	In the Force Voltage/Measure Current mode this output voltage is equal to four times the voltage across external resistor R of selected range A, B, C, or D through which the measured current is flowing ($(I/V)_M = 4.0 \times I_M \times R$). In the Force Current/ Measure Voltage mode this output is equal to the voltage at I/V out. This output can be disabled by applying a TTL HI on the V_{DIS} pin. (Pin 21)
V_{FB}	20	V_{FB}, voltage feedback, is the buffered output voltage, I/V_{OUT}. This pin should not be loaded. Connect a 50K 1% resistor from V_{FB} to CAP_V.
RADJ	10	The RADJ pin is provided to adjust the offset for the I_{SENSE} function. The best accuracy for V/IM is obtained when RADJ is shorted to analog ground. The point is terminated with a 100 Ω resistor in the block diagram.
CAP_I CAP_V CA	11 18 17	CA is the common point for two 50 pF compensation capacitors that improve the stability of the PMU. These components are optional and can be omitted for some loads.

Absolute Maximum Ratings[1]

Parameter	Min.	Max.	Units
Absolute Difference, $+V_S$+|–VS|		32	V
Digital Control Inputs			
SI/V, RS_1, RS_2, V_{DIS}	-2	+6	V
Comparator Inputs			
I/V_{MN}, I/V_{MX}	$I/V_{MN} \le +V_S$	$-V_S \le I/V_{MX}$	V
I/V_{IN}		$-V_S \le I/V_{IN} \le +V_S$	V

Notes:

1. Absolute maximum ratings are limiting values applied individually while all other parameters are within specified operating conditions. Functional operation under any of these conditions is NOT implied.
2. Applied voltage must be current limited to specified range, and measured with respect to GND.
3. Forcing voltage must be limited to specified range.
4. Current is specified as conventional current flowing into the device.

Recommended Operating Conditions

Symbol	Parameters	Min.	Typ.	Max.	Units
T_C	Case operating temperature	0		70	°C
$+V_S$	Positive supply voltage[1]	10.4	20.0	20.6	V
–VS	Negative supply voltage[1]	-15.75	-10.0	-9.5	V
V_{EE}	Negative supply voltage for range D[2]		$-V_S$		V
R_A	Resistor for I_A current range	100		2000	KΩ
R_B	Resistor for I_B current range	10		200	KΩ
R_C	Resistor for I_C current range	2		40	KΩ
R_D	Resistor for I_D current range	50		1000	Ω

Notes:

1. $+V_S$ + |–VS| ≤ 30V $+V_S$ + |–VS| ≥ 24
2. $-V_S$ & V_{EE} are always at the same voltage.

DC Electrical Characteristics

$+V_S$ = 20V ±3%, $–V_S$ = -10V ±5% T_A = 25°C, and external ±0.05% tolerance resistors R_A = 1000kΩ, R_B = 10kΩ, R_C = 2kΩ, and R_D = 50Ω unless otherwise specified.

Symbol	Parameters	Test Conditions	Min.	Typ.	Max.	Units
Forced Current/Measure Voltage						
I/V_{IN}	Input Voltage Range For Setting Forced Current (I_F)	I/VF_{IN} = 4 x I_F x R	-8		+8	V
I/V_M	Measured Voltage Output @ $(I/V)_M$	All ranges, full scale current	-5		+15	V
	Output Sink/Source Current	$(I/V)_M$ = -5V, +15V	-200		+200	µA
V_{MR}	Voltage Measured Resolution		-.05	±0.025	+0.05	%FSR
V_{OR}	Voltage Measurement Offset	I/V_{IN} = 0V; Measured @ I/VM	-6.0	±2	+6.0	mV
V_{GE}	Voltage Gain Error	Gain of 4	-2.0	+0.5	+2.0	%
CMRR[1] I_{OER}	I_{OUT} Error Due to Common Mode Load Voltage	-5V ≤ I/V_{OUT} ≤ +15V; Measured @ $(I/V)_M$	45	60		dB
Forced Voltage/Measure Current						
I/V_{IN}	Force Input Voltage Range	All ranges, full scale current	-5		+15	V
I/VF_{VOS}	Forced Voltage Offset	I/V_{IN} = 0V, measure I/V_{OUT} and VFB	-6.0	±2	+6.0	mV
	Forced Voltage Linearity Error			±0.025	±0.05	FSR%
CMRR[2] VLER	I_{OUT} Measure Error Due to I/VM Common Mode Voltage	-FSR ≤ I_{OUT} ≤ +FSR; Measured @ $(I/V)_M$	45	60		dB
I/V_{OUT}	Forced Output Voltage Range	All ranges, full scale current	-5		+15	V
I/V_M	Voltage Output Equivalent to Measured Current: $(I/V)_M$ = 4 x I_F x R	All ranges, full scale voltage	-8		+8	V
I	I measured; I = $(I/_{VM})/(4R)$	I/V_M = -8.0V, +8.0V; full scale	-200		+200	µA
Current Ranges						
Range A						
I_A	Maximum Full Scale Current	R_A = 100kΩ (0.05%)			±20	µA
I_{AMR}	Current Measurement Resolution	guaranteed by design		±0.025		%
I_{LIN}	Linearity[3]		-0.05	±0.025	+0.05	
I_{GE}	Current Gain Error[4]		-2.0	0.5	+2.0	%
I_{FIOS}	Force Current Offset[5]	I/V_{IN} = 0V	-25	±10	+25	nA
I_{MIOS}	Measure Current Offset[6]	I/V_{IN} = 0V	-25	±10	+25	nA
Range B						
I_B	Maximum Full Scale Current	R_B = 10kΩ (0.05%)			±200	µA
I_{BMR}	Current Measurement Resolution	guaranteed by design		±0.025		%
I_{LIN}	Linearity[3]		-0.05	±0.025	+0.05	
I_{GE}	Current Gain Error[4]		-2.0	±0.5	+2.0	%
I_{FIOS}	Force Current Offset[5]		-250	±100	+250	nA
I_{MIOS}	Measure Current Offset[6]		-250	±100	+250	nA

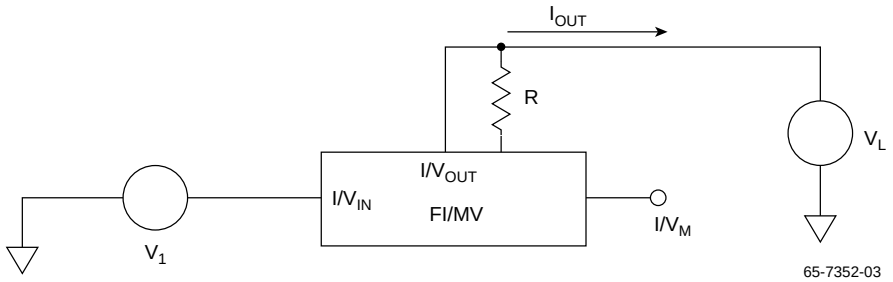
DC Electrical Characteristics (continued)

Symbol	Parameters	Test Conditions	Min.	Typ.	Max.	Units
Range C						
I_C	Maximum Full Scale Current	R_C = 2kΩ (0.05%)			±1	mA
I_{CMR}	Current Measurement Resolution	guaranteed by design		±.025		%
I_{LIN}	Linearity[3]		-0.05	±.025	+0.05	%
I_{GE}	Current Gain Error[4]		-2.0	±0.5	+2.0	%
I_{FIOS}	Force Current Offset[5]		-1.5	±0.5	+1.5	µA
I_{MIOS}	Measure Current Offset[6]		-1.5	±0.5	+1.5	µA
Range D						
I_C	Maximum Full Scale Current	R_D = 50Ω (0.05%)			±40	mA
I_{DMR}	Current Measurement Resolution Current Measurement Accuracy	guaranteed by design		±.025		%
I_{LIN}	Linearity[3]		-0.05	±.025	+0.05	%
I_{GE}	Current Gain Error[4]		-2.0	±0.5	+2.0	%
I_{FIOS}	Force Current Offset[5]		-50	±20	+50	µA
I_{MIOS}	Measure Current Offset[6]		-50	±20	+50	µA
Digital Control Inputs (SI/V, RS_1, RS_2)						
V_{IH}	Internal Threshold Voltage		0.8	1.4	2.0	V
I_{LH}	Logic High Bias Current	V_H = 2.0V		200		nA
I_{LL}	Logic Low Bias Current	V_L = 0.8V		2.0		nA
Digital Control Input V_{DIS}						
V_{IH}	Internal Threshold Voltage		0.8	1.4	2.0	V
I_{LH}	Logic High Bias Current	V_H = 2.0V		1.0		µA
I_{LL}	Logic Low Bias Current	V_L = 0.8V		2.0		nA
Comparator Input; I/V_{MAX}, I/V_{MIN}						
$I/V_{MX,MN}$	Input Voltage Range		-8.0		+15	V
I_H	Input Bias Current (Logic High)	V_H = +15V		0.4		µA
I_L	Input Bias Current (Logic Low)	V_L = 0.8V		0.4		µA
Comparator Status Outputs; V_{HF}, V_{LF}						
V_{OH}	Output Voltage (Logic High)	R_{PULLUP} = 10kΩ	3.5			V
V_{OL}	Output Voltage (Logic Low)	R_{PULLUP} = 10kΩ			0.8	V
I_{OH}	Output Current High	V_{OUT} = 5.0V		0.1		µA
I_{OL}	Output Current Low				1.0	mA
I_Z	Output Leakage Current Disable State	V_{OUT} = 5.0V		0.1		µA
Other						
I+ (1.0)	Positive Supply Current	No load Range A		4.0	11.0	mA
I- (2.0)	Positive Supply Current	No load Range A		4.0	11.0	mA

Notes:

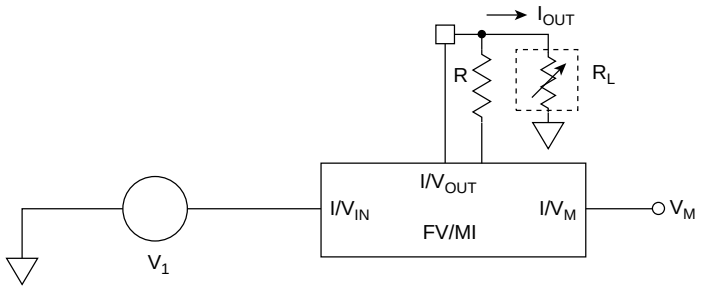
1. CMRR is measured with V_L=15V/-5V; R is R_A, R_B, R_C or R_D; V_1 = constant; This parameter is to define the I_{OUT} current error due to the V_L common mode voltage for a constant V_1. This parameter is guaranteed to full V_1 range. (±8V)

$$CMRR = 20 \log\left(\frac{\Delta I_{OUT} \times 4 \times R}{\Delta V_L}\right)$$



2. CMRR is measured with V_1 = +15V/-5V; R is R_A, R_B, R_C or R_D; I_{OUT} = constant. This parameter is to define the current measurement error due to the input voltage V_1. It guarantees all ranges and ± full scale I_{OUT}.

$$CMRR = 20 \log\left(\frac{\Delta V_M}{\Delta V_1}\right)$$



3. Linearity is measured against two point straight line calibration with five measurement points.
4. Current Gain Error is measured with –full scale current to +full scale current. The ideal gain is 4.

$$\text{Current Gain Error} = \left|\frac{VM_2 - VM_1}{R(I_{OUT2} - I_{OUT1})}\right|$$

5. Force current is measured with I/V_{OUT} to ground with I/V_{IN} = 0V.
6. Measured current offset is measured with I/V_{IN} = 0V, Offset = (I/VM)/4R where R is R_A, R_B, R_C, and R_D.

AC Electrical Characteristics

$+V_S$ = 20V ±3%, $-V_S$ = -10V ±5%, T_A = 25°C, and external ±0.05% tolerance resistors R_A = 100kΩ, R_B = 10kΩ, R_C = 2kΩ, and R_D = 50Ω unless otherwise specified.

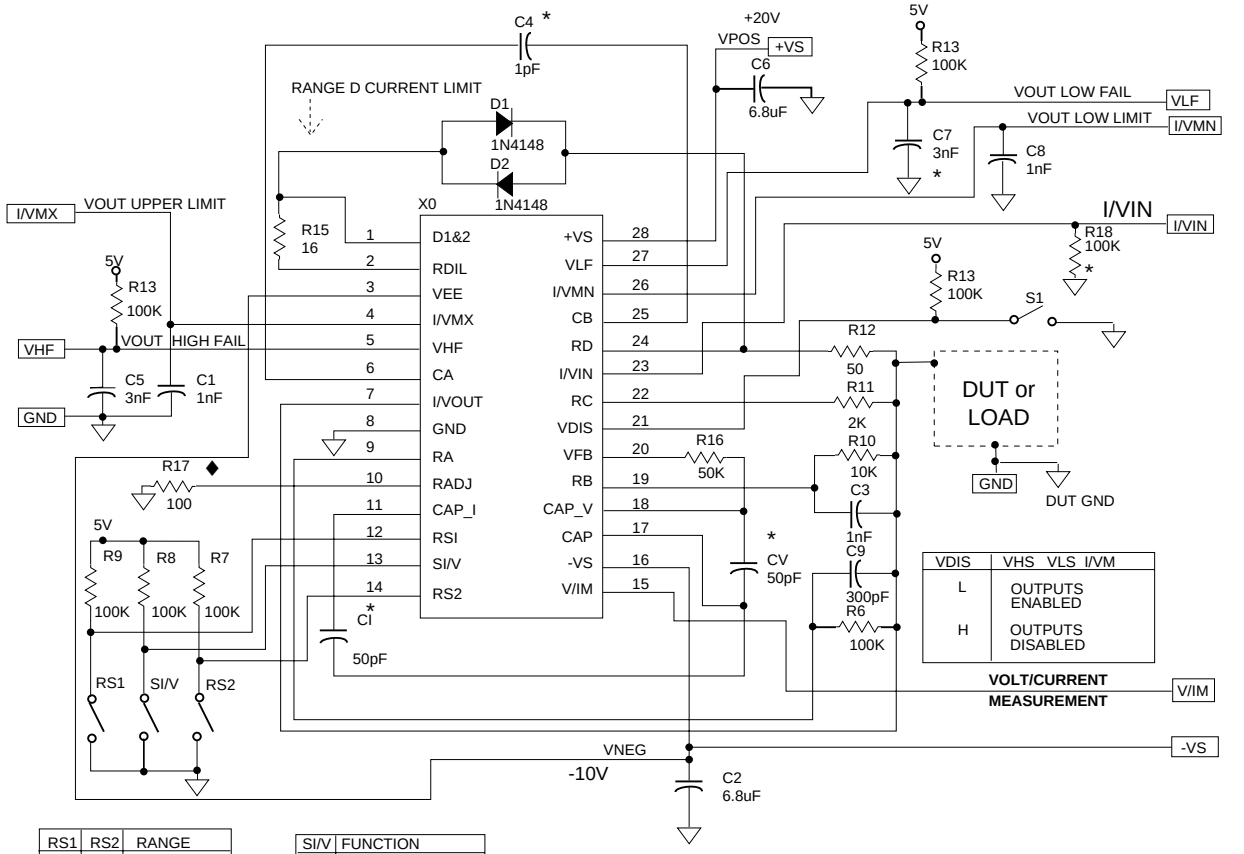
Symbol	Parameters	Test Conditions	Min.	Typ.	Max.	Units
Comparator						
t_{HL}	Response Time High to Low	R_{LOAD} = 10k, 5mV Overdrive		1.1		µs
t_{LH}	Response Time Low to High	R_{LOAD} = 10k, 5mV Overdrive		450		ns
Differential Amplifier						
t_{MZF}	Response Time (setting time)[1] Force Current/Measure Voltage	Range A Range B Range C Range D Voltage @ I/V_M = -5.0V to +15V I_F = Max		2.4 2.3 2.6 2.6		ms
t_{MZF}	Response Time (settling time)[1] Force Voltage/Measure Current	Ranges A Ranges B Ranges C Ranges D Voltage @ I/V_{OUT} = 5.0V to +15V I_M = Max		2.4 2.5 2.6 2.7		ms
t_{MZF}	Response Time (Settling time)[1]	Ranges A, B, C, & D Voltage @ I/V_{OUT} = -2.0V to +6.0V 30pF from CA to CB No Load		1.0	3	ms
t_{DS}	Output Disable to Enable Time			20		µs

Notes:

1. Response Time (settling time) for Force Current/Measure Voltage mode is measured with 30pF from CA to CB and I/V_{IN} Voltage Swings from -8.0V to +8.0V, and RL value for Range placed between I/V_{OUT} and 5V.

500KΩ	A
50KΩ	B
10KΩ	C
250Ω	D

Application Example



RS1	RS2	RANGE
L	L	A +/-20uA
L	H	B +/-200uA
H	H	C +/-1mA
H	L	D +/-40mA

SI/V	FUNCTION
L	FORCE VOLTAGE
H	FORCE CURRENT

* OPTIONAL PART

♦ SHORT RADJ TO GND FOR BEST DC ACCURACY

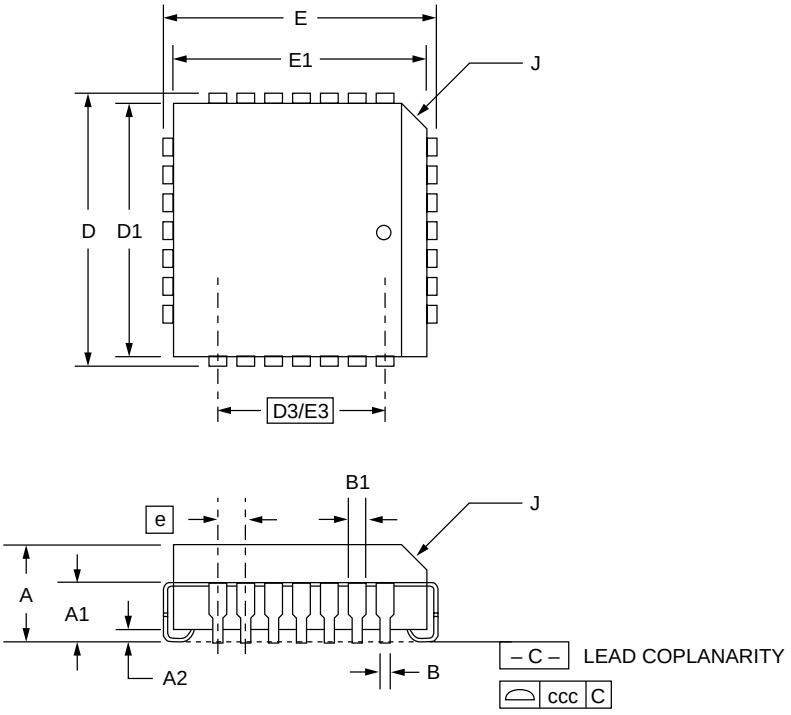
65-7352-05

Mechanical Dimensions

Symbol	Inches		Millimeters		Notes
	Min.	Max.	Min.	Max.	
A	.165	.180	4.19	4.57	
A1	.090	.120	2.29	3.05	
A2	.020	—	.51	—	
B	.013	.021	.33	.53	
B1	.026	.032	.66	.81	
D/E	.485	.495	12.32	12.57	
D1/E1	.450	.456	11.43	11.58	3
D3/E3	.300 BSC		7.62 BSC		
e	.050 BSC		1.27 BSC		
J	.042	.048	1.07	1.22	2
ND/NE	7		7		
N	28		28		
ccc	—	.004	—	0.10	

Notes:

1. All dimensions and tolerances conform to ANSI Y14.5M-1982.
2. Corner and edge chamfer (J) = 45°.
3. Dimension D1 and E1 do not include mold protrusion. Allowable protrusion is .101" (.25mm).



Ordering Information

Part Number	Package
RC7352QA	28-pin PLCC